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Biological Notes on Indian Bamboos.

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Indian Foresters, who have had the good fortune of witnessing the flowering and seeding of some of the gregariously and periodically-flowering Bamboos, will probably agree with me in thinking, that a series of remarkable phenomena on a grand scale takes place before our eyes, opening up a multitude of interesting questions, many of which still await solution.

BIOLOGICAL CLASSIFICATION OF BAMBOOS.

Before, however, proceeding further, it will be well to come to an understanding regarding the classification of Bamboos from a biological point of view. The classification, which I have in my mind at present, is two-fold, in regard to the growth of the rhizome, and in regard to the mode of flowering.

In regard to the rhizome we have two classes: those which form large, more or less dense, tufts or clumps, such as *Bambusa arundinacea* and *Dendrocalamus strictus*; and those, the rhizome of which sends out long underground branches, which bear isolated stems or small tufts of stems. The Bamboos of the latter class exhibit great variety in their manner of growth. That remarkable species, which covers large areas in the Maytharouk forests of the Upper Salween district, and which is described in para. 368 of my *Burma Inspection Report of 1881*, only has separate stems, which are evenly distributed over the forest. Several species of *Phyllostachys*, on the other hand, form clumps or clusters, but the rhizome sends out long branches running underground, which, at some distance from the mother clump, bring forth single stems or tufts of a few stems each. Between these two extremes there are numerous intermediate forms.

Matters are analogous, when we attempt to classify Bamboos according to their habit of flowering. A number of species flower annually, the same clump has leaf-bearing and flowering stems, the latter terminate in a flower panicle and bear leaves in the lower portion. In South America these annually-flowering species are common, and they belong to *Arundinaria*, *Bambusa*, *Guadua*, and other American genera. In India the number of species known to flower annually is limited. The one best known is *Arundinaria Wightiana*, Nees, on the Nilgiris and on other hills near the Western Ghâts. There may be others besides, for a number of species have leaves on and below the flower panicle, which however does not necessarily prove that the species flowers every year. Other annually-flowering species are *Ochlandra stridula*, Thwaites, of Ceylon, and *Bambusa lineata*, Munro, a shrubby species of the Andamans and the islands of the Indian Archipelago. At the other end of the series stand those Bamboos which we generally designate as flowering periodically and gregariously, and of these *Bambusa arundinacea* and *polymorpha* may be mentioned as types. Between these two extremes there are numerous species which occupy an intermediate position in regard to their habit of flowering. Of these, some at times are found in flower over large areas, and after a series of years they are found to flower again in the same locality. The same species, however, is also found to flower sporadically, and in such cases leaf-bearing stems are not rarely found in a flowering clump, and at times some of the flowering stems bear leaves. Of these intermediate species, which we may term irregularly-flowering, the one best known is *Dendrocalamus strictus*.

Those who have witnessed the periodical flowering of species of *Strobilanthes* on the Nilgiris, and the gregarious flowering of Bamboos, doubtless have been struck by the coincidence of gregarious habit and periodical flowering. *Strobilanthes Kunthianus* flowers in periods of 5 to 6 years, *S. sessilis* flowers every fourth or fifth year, *S. gossypinus* every tenth year. All these three species are eminently gregarious, covering almost exclusively large areas on the slopes. *Bambusa arundinacea*, *polymorpha*, and *Dendrocalamus strictus*, are all eminently gregarious. It does not however follow, that all gregarious Bamboos or *Strobilanthes* flower periodically, or that the annually-flowering species should occur only sporadically. Two annually-flowering *Strobilanthes*, *asper* and *luridus*, form the underwood in sholas over large areas or at least did so formerly. *Arundinaria Wightiana* is gregarious, and of *Ochlandra stridula*, Trimen reports that it covers hundreds of square miles of country in the South and West of Ceylon.

So far regarding the classification of Bamboos with reference to their mode of growth and their manner of flowering. The

systematic classification has been placed upon a solid footing by the description and figures in Mr. Gamble's admirable Monograph.* To talk of the habits of Bamboos and of the management of Bamboo plants, has little meaning and is of no practical use. Each species has its own peculiarities and its own requirements, and as the number of known Indian species is about 120, it follows, as a matter of course, that without a reliable guide, the study of Bamboos in India would be hopeless. Mr. Gamble's work will enable Indian Foresters to determine more fully the peculiarities and requirements of all important kinds.

BAMBUSA POLYMORPHA.

On my first journey across the Pegu-Yoma range, from Toungoo to Prome, in April 1856, in the Khaboung and Nawing Forests, I greatly enjoyed the shade of *Kyathaunwa*, *Bambusa polymorpha*, which was in full leaf, forming a high dense underwood under the tall trees of *Xylia dolabriformis*, *Terminalia tomentosa*, Teak and other kinds. Again, in 1857 and 1858, I spent the greater part of the dry season in the *Kyathaunwa* forests on the Pegu-Yoma of the Tharawaddi and Prome districts.

In the hot season of 1859, the same species came into flower in this part of the country; and in March 1861, the hills a little further North, at the headwaters of the Choungoungyee and Swah rivers, were quite impassable, because the dry stems of *Kyathaunwa* had fallen, forming a tangled mass, which had blocked up every pathway. The same thing had happened in the southernmost portion of the Pegu-Yoma, for I find in my diary of 20th December 1860 the following entry regarding the Magayee forests on the hills near the Upper Kayoo Choung "*Kyathaunwa* has flowered in 1859, its dry stems make the forest almost impassable," and it is well known that *Kyathaunwa* in 1859 flowered all along the west side of the Pegu-Yoma in the Tharawaddi and Prome districts. In that year I was not in the Pegu Forests, but (December 1858 to June 1859) was at work in the forests of Martaban and Tenasserim. I have, however, in my herbarium, flowering specimens collected in 1859.

In 1861, I crossed the Yoma range on my march from the Irawaddi to the Sitang river. I had heard that Major Phayre, the Commissioner of Pegu, was coming on the same line in an opposite direction. As I wished to meet him at a particular spot on the Yoma range, I left servants, baggage and horses behind, and for many hours scrambled in the burning sun over the masses of fallen Bamboos, until I met a

*The Bambuseae of British India, Vol. VII of Annals of the Royal Botanic Garden, Calcutta, 1896.

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party of Kareus, who were clearing the way over the hills for the Commissioner's camp, when progress became easy and rapid. This was on the 2nd March 1861. We spent a delightful evening together, settling many things relating to the management of these Teak forests. We had no idea then, that a despatch from the Government of India was on its way from Calcutta to Rangoon, ordering the Teak Forests of Pegu to be thrown open to private enterprize. This, however, as well as the measures which the Commissioner and myself took, when we had received and had discussed that despatch, in order to carry out the instructions contained therein, does not affect the growth of Bamboos, and need not, therefore, be related on the present occasion.

DEVELOPMENT OF BAMBOO CLUMPS.

The jungle fires of March, April and May subsequently swept away the tangled masses of dry stems, and after the rains of 1861, the ground everywhere was covered by millions of seedling Bamboos, which soon grew up into slender plants, 2 to 3 feet high, forming dense waving green masses on the ground under the trees.

The first process which takes place is, that among those millions of plants the strongest get the upper hand, and that they gradually grow into those remarkable clumps or bushes which consist of a huge underground rhizome composed of innumerable stout twisting branches, which rhizome carries a large number of leaf-bearing culms or stems. The development of a Bamboo clump from a slender seedling is a most remarkable process, which has not yet been studied sufficiently. It may interest Indian Foresters to read what I have been able to ascertain on this subject, and my hope is that the imperfect data, which I now place before them, may induce my younger friends to follow up this subject, and some day to publish a complete account of it in the pages of the *Indian Forester*.

BAMBUSA ARUNDINACEA.

On the Poratty saddle at the headwaters of the Noyil river in the Coimbatore district of the Madras Presidency, in March 1882, I came across large patches of young seedlings of *Bambusa arundinacea*. The species had evidently flowered in 1881, and the seed had germinated during the rains of that year but exhibited different stages of growth. The youngest of these plants consists of one shoot, about 6 inches long, bearing 2 or 3 leaves at the top, and below these a sheath of the usual length, furnished, not with a complete leaf, but with a small imperfect blade. Near the ground the

shoot bears a short membranous-pointed sheath, at the base of which there are two rootlets, about 3 inches long. At a later stage, just below the surface of the ground, several conical side shoots make their appearance, which are bent, first downwards, then upwards, and which are covered with numerous white membranous sheaths. These side shoots afterwards ramify, and they are the beginning of the rhizome. At the bend they send rootlets down into the ground, while at the top they produce a leaf-bearing stem. Besides these side shoots with short internodes, which are therefore completely covered by the overlapping membranous sheaths, there are underground shoots with moderately long internodes, which root at the nodes and which, from these points, also send up leaf-bearing stems.

In this manner it happens that seedlings, not quite a year old, have an underground rhizome of complicated build, sending numerous rootlets into the ground, and bearing a number of stems. I have such specimens before me, with six stems, some of which are 12 inches long and are furnished with 6 to 8 leaves. The stems first formed are short-lived, and in some of the more advanced seedlings, they are dead and dry.

OTHER SPECIES.

In all essential points the mode of development is the same in those species which I have been able to examine. To the kind attention of Mr. Oliver and Mr. Gamble, I owe a valuable collection of seedlings of different species in two stages, 12 and 24 months' old.

Bambusa Tulda, Roxb. 12 months old: First shoot dead, the second branched, two lateral shoots at the ends of short rhizome branches, which are covered with membranous sheaths. Shoots 8 inches long, with 5 to 7 leaves. Rootlets numerous, 6 inches long.

The same, 24 months old: Rhizome 2 inches in diameter, consisting of 6 stout short branches, which are bent in the middle and are entirely covered with broad, short, pointed, glabrous, shining and ribbed membranous sheaths. Four of these rhizome branches bear at their ends leaf-bearing shoots, which are all branched, the longest being 18 inches long. Primary shoots in the centre, all dead. Rootlets numerous.

Bambusa Oliveriana, Gamble. 12 months old: A well-formed rhizome, the branches bent in the usual way; 2 or 3 primary shoots dead, 3 or 4 lateral shoots, all branching from the base, the branches not easily distinguished from the main shoots, thin, 12 inches long.

The same, 24 months old. The portions of a rhizome separate readily from each other; branches long, hooked, entirely covered with short, broad, membranous sheaths. Shoots much branched, 16 inches long.

Bambusa longispiculata, Gamble, nova species. 12 and 24 months old. Development of rhizome and of shoots similar to *B. Tulda*.

Dendrocalamus strictus, Nees. Branches of rhizome very long (2 inches) creeping horizontally, at the ends bent upwards, sending up shoots, some of which are undeveloped. Rhizome sheaths broad, ribbed, hairy and ciliate at the edges. First primary shoot dead, second branched; one side shoot only at the end of a rhizome-branch developed. Longest shoot, 15 inches long with 7 leaves.

The same, 24 months old. Rhizome branches very stout at the bend, $\frac{3}{4}$ inch diameter. All shoots branched, youngest $\frac{1}{2}$ inch diameter at base. Shoots 30 inches long.

Dendrocalamus membranaceus, Munro. Development of seedlings similar to that of *D. strictus*, but rhizome branches not so long. Rhizome sheaths hairy and ciliate at the edges.

Dendrocalamus Brandisii, Kurz, 12 months old. Rhizome branches short, bent at their ends. Unbranched shoots, the longest 18 inches long, bearing eight leaves. Rootlets very numerous, 9 inches long, much branched.

Cephalostachyum pergracile, Munro, 12 months old: Branches of rhizome much bent, each bearing a shoot, the largest of which is 12 inches long with five to six leaves. Primary shoots dead.

The same, 24 months old. Rhizome much developed, branches long, growing more downwards than sideways. Shoots much branched, the largest $\frac{1}{2}$ inch diameter, 25 inches long.

THE RHIZOME OF SINGLE-STEMMED SPECIES.

The species just described are all tufted or caespitose. *Dendrocalamus membranaceus*, according to Gamble, forms loose clumps, in the others the clumps are dense, bearing numerous stems closely packed. Of single-stemmed species I have no early stages, but I owe to Mr. Gamble a specimen of *Arundinaria jaunsarensis*, apparently just full grown, as some of the stems have their full size, $\frac{1}{2}$ inch in diameter. It consists of a rhizome bearing six stems, two of which have the full thickness of $\frac{1}{2}$ inch, while the others are smaller. This rhizome sends out in different directions, three long, more or less, horizontal branches, with internodes about half an inch long. Two of these are broken off, the third is 30 inches long, straw-coloured, shining, slightly ribbed and marked by the oblique raised lines, where the sheaths were attached. The sheaths are mostly fallen, they are glabrous, shining, triangular and acuminate, about $1\frac{1}{2}$ inches long. The diameter of this underground branch is uniformly $\frac{1}{4}$ inch.

At the end it bears a second rhizome, with two culms of nearly the full thickness; and from this second smaller rhizome, proceed in different directions, two other underground rhizome branches, similar to the one just described. These two rhizome branches are broken off.

It may perhaps for the present be assumed, that those Bamboos, which have both culms in tufts and single stems, grow in the manner here described for *Arundinaria jaunsarensis*. To these belong several species of *Phyllostachys* from China and Japan, particularly *Phyllostachys bambusoides*, Sieb. et Zucc, the tufts of which send out numerous creeping underground branches. These bear single culms, or small tufts of a few culms each, which come up in paths or in the midst of a flower bed. This habit of *Phyllostachys* gives gardeners in Europe much trouble, where they are cultivated.

Whether the other single-stemmed Bamboos grow in the same manner, I am unable to say. I would specially recommend to the attention of Forest officers, who may be disposed to enquire into this matter, the single-stemmed Bamboo previously noticed, which is called Tabendein Wa by Burmans, and Wabgai by Karens. It was found by me in the Upper Salween and the Yoonzaleen forests and is mentioned in paras. 368 and 372 of my Suggestions regarding Forest Administration in Burma of 1881. This species never forms tufts, but all stems come singly out of the ground at even distances from each other. An accurate description of the development of the creeping rhizome of this species from the seedling would be most interesting. Formerly, I regarded this Bamboo as *Bambusa villosula*, Kurz, but Mr. Gamble, who has kindly examined my specimens, refers them to *Gigantochloa macrostachya*, Kurz, which however is described as caespitose.

SINGLE-STEMMED BAMBOO OF THE WESTERN GHATS.

Other single-stemmed species are *Arundinaria racemosa*, Munro; *A. Rolloana*, Gamble; *Bambusa nutans*, Wall; *Melocanna bambusoides*, Trinius; *Pseudostachyum polymorphum*, Munro.

A single-stemmed *Oxytenanthera* I would specially recommend to the attention of Forest Officers in Coorg, Mysore and the Southern portion of the Bombay Presidency. Regarding this species, which probably is *Oxytenanthera monostigma*, Bedd. my diaries and rough notes have the following entries.

23rd April 1868, south of Anantapur (Shimoga district of Mysore): "Hills covered with dry forest, with the small bamboo 'found first in south Coorg and afterwards in the Luckovalli 'forest in Mysore. It is called Seeb hen, Galti, in Luckovalli. Its

characters are the isolated stems, almost solid when mature, long sheaths with long narrow blades, small leaves and long-pointed, almost spinescent spicules."

2nd April 1870, in the North Kanara Teak Forests : "Four species of Bamboo, (1) *Bambusa arundinacea* (2) A climbing Bamboo (3) *Dendrocalamus strictus*, (4) Chiwa, Mar.; Chua, Chawa, Kan. Stems isolated, when young clothed with whitish velvet, grey when old. Internodes 15 to 18 inches long. Culm sheaths as long as internodes."

5th May 1870. Between Mulla and Helwauk on the Sattarah ghâts. "Bamboo is found all over the jungle of these villages, but so stunted and hacked, that I did not see one well-grown clump. The people call it Chiwa, the stems are generally solid and when young covered with whitish down, just like the Chiwa of Kanara. They say that the culms grow about 9 feet high."

Of this species I have specimens in flower collected in April 1870 in the North Kanara Teak Forests, and Gamble (page 74) mentions specimens collected by me in Coorg and North Kanara. These specimens probably are at the Calcutta herbarium. The chief reason why I am not quite certain about the species is that Mr. Talbot in his most useful systematic list of trees and shrubs of the Bombay Presidency does not mention that *Oxytenanthera monostigma* has the stems isolated and not in tufts or clumps as most other Bamboos. The climbing (rather semi-scandent) Bamboo mentioned above is doubtless *Teinostachyum Wightii* Bedd.

DEVELOPMENT OF LEAF-BEARING STEMS.

We now return to the development of the cæspitose species. Every year the rhizome sends up a number of fresh shoots; and, as the rhizome increases in size, the shoots are stouter and larger every year, until they have attained their full size. At that time, we may say, the clump has attained maturity. The number of years required, until this point is reached, doubtless is different for the different species, but it probably also varies with soil and climate.

Very little certain information is available regarding the time required for the seedling Bamboo to attain maturity. Of *Bambusa arundinacea* at Dehra Dûn, A. F. Broun reports that clumps five years old had produced shoots 6 to 10 ft. long. In the Pandratola reserve on the South face of the Satpura range in the Central Provinces, the same species had flowered in 1869. When I visited this forest in February 1876, the thickets of young plants which had come up in place of the old clumps were 15 ft. high. As a rule, this species is 70 to 90 ft. high when the rhizome has attained maturity. From Travancore

Mr. Bourdillon reports that *Bambusa arundinacea* was full-grown 12 years after seeding (I. F. XIII, p. 579). In a later communication (I. F. XX, p. 469) he states that 8 or 10 years must elapse before full-sized culms of this species can be obtained. Mr. Jasper Nicholls says his experience is, that no clumps can be said to come fairly into bearing full-sized stems in less than 15 years, (I. F. XXI, p. 95). *Bambusa polymorpha*, which had flowered in the Pegu-Yomah hills in 1859, had, when I visited those hills in 1868, grown up into a forest similar to that which I had known before flowering; the tufts, however, were small, that is, they had not yet as many stems as formerly. I have said the rhizome has attained maturity when it produces culms of the usual full size. By the formation of new underground branches, however, the rhizome continues to expand up to a certain size, and consequently bears a larger number of stems when older.

It is not, however, the age of the rhizome alone which influences the size of the stems produced by it; the vigour of the rhizome is influenced by other conditions also. Before fire protection was commenced in the Bori Forest of the Central Provinces, the stems of *Dendrocalamus strictus* produced under the régime of the annual fires, were short and small. After fires had been excluded during a number of years, and the soil had become soft and enriched by the decay of the leaves, the stems produced by the same clumps increased in length and thickness. The same species in Pegu, on dry hills, only has culms 30 feet long, while clumps on the rich, deep soil of a dell produce stems 40 to 50 feet long. Mr. Jasper Nicholls, speaking (I. F. XXI, p. 91) of the extraordinary length of Katang Bamboo poles sent from the Balaghat district to the Nagpur Exhibition, Christmas 1865, accounts for their unusual length in this way: "These bamboo clumps grew 'on deep soil, in a moist valley, very close to one another.'"

On the other hand it is well known, that clumps which are weakened by overcutting, gradually produce shorter and thinner stems.

And when all stems are cut, the rhizome only produces thin, whip-like branches. This fact may be said to constitute one of the great points of difference between a Bamboo Forest and a coppice wood. In an Oak coppice, all shoots are cut when they have attained the requisite age, and the rootstock, if strong enough and healthy, next year will produce a crop of shoots of the same size. The coppice shoots of Dicotyledonous trees, however, have this point in common with Bamboos that the rootstock, say of a Teak seedling, which has been cut down by the jungle fires, in the first year produces small and weak shoots, but through the action of the leaves, gradually gets strength enough to send forth stout tall shoots, which resist the action of the fires.

THE FLOWERING OF BAMBOOS.

We now approach the important question, whether the gregariously-flowering Bamboos always and necessarily come into flower, when the rhizome has attained a certain age. Before, however, attacking the general question, it will be well to mention, that there is no absolute regularity in this matter. A species may come into flower simultaneously in a certain tract of country, while in an adjoining tract the flowering takes place a few years later. And there is no doubt, that frequently individual clumps come into flower, either after a general flowering has taken place, or in advance of it. Thus I see it noticed in Mr. Gamble's excellent work on the Bamboos of British India, page 87, that *Bambusa polymorpha* was collected in flower by me in 1862 in the Zamayi forests, and afterwards by Sulpiz Kurz in the Thaukyeghat district in 1871. The specimens of these two gatherings are, I presume, at the Calcutta Herbarium. In the Zamayi (Upper Pegu) forests, I was at work from 18th January to 7th February 1862, but the Forest diary which I have now before me, does not mention the flowering of Kyathounwa, nor does it mention that the ground was covered with seedlings of that species. My opinion is, that in the Zamayi forests, which occupy the high hills at the head-waters of the Pegu river, Kyathounwa did not flower in 1859, though the same species in that year came into flower all over the west side of the Yoma range at the head-waters of the streams which run into the Irrawaddi and Hlaing rivers. I am disposed to think, that the specimens gathered in 1862 and 1871, must have come from clumps which had flowered out of their time.

It may not, I fear, be possible to put together at the present time, a complete history of the flowering of *Bambusa polymorpha* in Pegu in 1859 and subsequent years. This shows how necessary it is, that the flowering and seeding of all periodically-flowering Bamboos should be fully recorded at the time this event takes place. An excellent plan would be, if some Forest Officer in Burma would take the trouble once a year to send to the "Indian Forester" a statement of the species which have flowered during the year in that province as well as of the area over which the flowering of each species had extended.

BAMBUSA ARUNDINACEA.

That species, regarding the periodical flowering of which the most complete data have been collected, is the spinescent thick-walled Bamboo, which is common in both the Western and Eastern Peninsula, and which is cultivated largely in Northern India, *Bambusa arundinacea*. In his Forester's Manual

for Southern India, page 229, Colonel Beddome records that on the West side of the Peninsula, viz. in Malabar, South Kanara, the Wynaad and Coorg, this species had flowered three or four years before 1869, say in 1866, that a similar event took place about 30 years previously, say in 1836, and that from records he saw, it had occurred also in 1804. The conclusion seemed natural, that this species comes into flower when it has attained the age of about 30 years. Two successive flowerings are also recorded for this species (planted) at Dehra Dún, 1836 and 1881, with an interval of 45 years.

General flowerings of this species are on record for many districts from 1804 to 1896. In the following list I have entered those which appeared to me to be authentic, and wherever it seemed necessary, I have indicated where such flowering is recorded.

- 1804 Western Coast districts, Beddome.
- 1812 Orissa, S. Kurz, I. F. I, 259.
- 1817 South Travancore, Bourdillon, I. F. XX, 469.
- 1836 Dehra Dún, (planted) and Western Coast districts.
- 1839 On the Nerbudda river, between Jubbulpore and
Mandla, Munro Trans. Linn. Soc. XXVI, 3.
- 1864 North Kanara, S. Kurz, I. F. I, 259.
- 1865 Balaghat district, Central Provinces.
- 1868 Western Coast districts, Beddome.
- 1869 Pandratola Reserve, South face of the Satpura range.
Central Provinces, D. Brandis.
- 1870 Jubbulpore (planted) "four-fifths of the Bamboos in
Sleeman's park and throughout the station burst
into flower, seeded and died." Jasper Nicholls in
I. F. XXI, 91.
- 1870 Portion of South Travancore, Bourdillon, I. F. XX 469.
- 1879-80 North Travancore, Bourdillon. I. F. XX, 469.
- 1880 Oudh, Capt. Wood. I. F. VII, 59.
- 1881 Dehra Dún (planted) I. F. VI, 336.
- " Basudeo, Kumaon I. F. XII, 413.
- " Poratty saddle, head-waters of Noyil, Coimbatore
district, D. Brandis.
- 1882 Travancore, Bourdillon, I. F. XIII, 409.
- " Narsinghpur, two clumps in the Deputy Commis-
sioner's compound, Jasper Nicholls I. F. XXI, 91.
- 1885 Rajim on the Mahanadi river, Central Provinces,
Jasper Nicholls, I. F. XXI, 92.
- 1889 Nallamalai Hills, Kurnool, Gamble, Bamboos, p. 54.
- 1894 Cuddapah, Gamble, Bamboos, p. 54.
- 1896 Rajpipla State, I. F. XXII, 222.

The question evidently demands more study in detail. Each district must be taken up separately, and the successive flowerings in that district must be determined. We ought to bear in mind what Mr. Bourdillon states regarding the seeding of this

species in Travancore in 1882 (Indian Forester XIII, p. 579.), "The seeding was not general all over the country. South of 'a certain line the seeding took place about a dozen years ago, 'and the bamboos thus are now full grown. Isolated clumps 'in the cultivated parts also failed to seed."

The simultaneous flowering and seeding of this species, as well as of *Bambusa polymorpha*, may at times extend over a considerable area, yet it always is local. Occasionally the flowering in remote districts may coincide, as was the case in 1836 at Dehra Dún and on the Western Coast, in 1870 at Jubbulpore and South Travancore, but this is accidental. Nor has a regularly periodical flowering yet been proved for any particular district.

OTHER PERIODICALLY-FLOWERING SPECIES.

Regarding *Bambusa Tulda*, the species most commonly cultivated around the villages of Lower Bengal, which is indigenous in Assam and is well known in Burma as Thaikwa, Gamble says that it undoubtedly has the habit of flowering gregariously over considerable areas. The flowering of this species has been reported for the following years.

1866	Malda district, Lower Bengal.*
1867 and 1868	Lower Bengal, Kurz.
1872	" " C. B. Clarke.
1884	" " "
1876	Chittagong, Lister.
1886	" Ellis.
1863 to 1868	several times, Burma, D. Brandis.
1880	" "
1889	Assam " Gustav Mann.

Isolated clumps of this species, however, not rarely come into flower, and it may be doubted whether *Bambusa Tulda* should be classed among the strictly periodically and gregariously-flowering species.

I will here mention the Bamboo described by Nathaniel Wallich, the Superintendent of the Calcutta Gardens, in a Report to Government of 1825, extracts from which are given on page 376 of the "Indian Forester," Vol. VII. This celebrated Bamboo grove surrounded the city of Rampore in Rohilkhand to a breadth of 30 to 40 ft. The whole flowered in 1824, not a single stem being seen which was not dead, they were all leaning on each other or had fallen to the ground thickly covered by myriads of seedling Bamboos growing under the protection of the dead

*Munro Trans. Linn. Soc. XXVI, p. 4, says that the seeds were eaten during that year of scarcity. It most probably was *B. Tulda*. See also Kurz (Indian Forester I, p. 259).

stems. Dr. Wallich was told that 40 years ago the grove had been reproduced in the same manner, and that similar renewals had succeeded each other for ages past. Wallich found this Bamboo to be of the common *unarmed* kind. There is no indication of the species in the extract, it may have been *Bambusa Tulda*, *Balcooa* or *nutans*.

A large Bamboo, which is believed to flower at long intervals, is *Bambusa nutans*, Wall., indigenous in Eastern Bengal and Assam, and cultivated near villages in Dehra Dún. This is one of those species, the stems of which do not grow in dense clumps, but arise singly from a creeping rhizome. In the Dún it flowered in 1840, and has for some years past been expected to flower again.

Another single-stemmed Bamboo is *Melocanna bambusoides*, Trinius, of Eastern Bengal and Burma. Munro reports that it flowered and seeded in 1863 to 1866 all over the Chittagong hills, so much so, that it caused a great scarcity of building materials. In Assam it came into flower in 1892. Kurz (Indian Forester I, 257) and Gamble (Bamboos, 120), are of opinion that its period is about 30 years.

Regarding some of the large Bamboos of the Indian Archipelago, Kurz (Indian Forester I, 257) thinks that the clump, that is the rhizome, attains the age of 100 years.

A number of the smaller Bamboos (*Arundinaria*, *Phyllostachys*) appear also to flower periodically and gregariously.

Arundinaria spathiflora, Trinius, the Ringal of the North-west Himalaya, which grows as a thick underwood at elevations from 7,000 to 10,000 feet, in Forests of *Quercus semecarpifolia*, *Pinus* and *Abies*, was found in flower by Wallich, in 1821, in Nepal; has flowered in Jaunsar in 1881 (D. Brandis), and 1882 (W. R. Fisher); and was again found in flower by Gamble in 1892 at Deoban and in 1893 on Kedarkanta.

Arundinaria intermedia, Munro, in the Eastern Himalaya, growing gregariously between 4,000 and 7,000 ft. was first found in flower by Hooker in 1848, by T. Anderson in 1868, and by Gamble in 1879. The two species would seem to have a period of 9 to 10 years, but Gamble justly draws attention to the fact that isolated flowering clumps are occasionally met with.

Regarding the gregarious flowering of some Japanese and Chinese species of *Arundinaria* and *Phyllostachys*, interesting data have been published in a work by A. and C. Rivière * *Arundinaria japonica*, which had been introduced from Japan about 20 years previously, flowered in 1867 and 1868, nearly simultaneously in the Bois de Boulogne, at Sceaux, at Marseilles and in the large experimental Garden of Hamma in Algiers.

* Les Bamboos, par Auguste Rivière et Charles Rivière, Paris 1887,

Arundinaria falcata flowered about 35 years after having been introduced in 1875, at Angers, Nantes, Hamma, and a little later (in March and April 1876) at Paris.

Phyllostachys flexuosa had been brought from China in 1864 and flowered at Hamma in February 1876, at Toulon in May, and at Paris in July of the same year. It will be noticed that the two last species came into flower at a later date in a colder climate.

THE PERIODICALLY-FLOWERING STROBILANTHES COMPARED WITH BAMBOOS.

There is some analogy between the gregarious and periodically-flowering Bamboos and those species of *Strobilanthes*, which are gregarious and flower at certain intervals, after periods of from 5 to 12 years. In both instances there is an underground rootstock or rhizome, which annually sends up leaf-bearing stems. When the rootstock has attained a certain stage, and when sufficient stores of starch and other substances have been accumulated in it to furnish the needful materials for the development of flowers and seeds, then flower-buds instead of leaf-buds are formed on the branches, the stems are covered with flowers and seeds and after the seeds have ripened, the whole plant dies.

As far as our present knowledge goes, the period of flowering in the case of species of *Strobilanthes* are fixed for each species, while in the case of the gregarious and periodically-flowering Bamboos, there appears to be a considerable latitude. With regard to Bamboos, the great irregularity in the periods of flowering makes it impossible to entertain the assumption that, when the rhizome of a Bamboo clump has attained a certain age, it must necessarily produce flowers and seed in the place of leaves. A more likely assumption seems to be that the condition of the rhizome, that is, the accumulation in it of a sufficient quantity of starch and other substances, is one of the conditions that must be fulfilled before flower-buds can be formed in the place of leaf-buds. Other conditions, however, must co-operate before the formation of flower-buds can actually take place. These conditions may depend upon soil, upon climate, or upon other matters.

THE FLOWERING GOVERNED BY OTHER CIRCUMSTANCES BESIDES AGE.

In this respect some remarks made by the late Sulpiz Kurz in an excellent paper on Bamboos (*Indian Forester* I, 259) merit special attention. During the two dry seasons of 1868 and 1869, which he spent in Burma in order to collect data for his *Forest Flora*, he was so fortunate as to collect an

unexpectedly large number of Bamboos in flower. This he ascribes to the unusual heat and drought of those seasons. Again, he says that in the Calcutta Botanic Garden there never had been so many species in flower as in 1874, which was a year of great drought and scarcity in Lower Bengal.

It has above been stated, that *Bambusa arundinacea* flowered in 1864 in North Kanara, and in 1865 in the Balaghat district of the Central Provinces, and that a general flowering of *Bambusa Tulda* in the lower Provinces of Bengal took place in 1866. And certainly in Bengal, and in a large portion of the peninsula was the Monsoon of 1864 and 1865 quite insufficient, and consequently there was great drought and heat. But it can in no way be maintained that the years of Bamboo-flowering have always followed years of drought and scarcity.

Nevertheless, it is quite possible that when the rhizome has attained that stage when flowering would be possible, an unusually dry and hot season may have the effect of accelerating the formation of flower-buds in the place of leaf-buds. It should be remembered, that such stimulating conditions must act upon the plant, at least a year before the flowering actually takes place.

EUROPEAN FOREST TREES FLOWER AND SEED AT IRREGULAR INTERVALS.

Those readers of the "Forester," who have had the privilege of seeing some of the forests of Europe, will remember that the European Forest trees, the Beech, the Oak, the Spruce and the Silver Fir, do not flower and seed regularly every year, but at intervals which vary in each species with soil, elevation, climate and other conditions. They may also remember the admirable researches made by Robert Hartig at Munich in 1888 on the part which the accumulations of starch in the medullary rays and wood parenchyma of the Beech tree play in regard to the seed years of that species.

Formerly it was supposed that the stores of starch and other reserve substances, which are deposited in the wood of Beech trees, were consumed by the development in spring of the leaves. Robert Hartig, however, has proved that the starch in the wood gradually accumulates, until a mark year arises, when it is entirely consumed by the development of the flower and the formation of the seed.

It is probable that a similar process takes place in the case of all trees which flower and seed at intervals of several years; and it is not impossible, that before periodically-flowering Bamboos are in a position to form flower-buds in the place of leaf-buds, the rhizome must have attained a certain condition, that is, it must contain sufficient accumulations of starch and other reserve substances.

IRREGULARLY-FLOWERING SPECIES.

So far regarding those species, which always flower simultaneously over large tracts of country, all stems of each clump producing nothing but flowers and seed. There are many other species, which are more irregular in their habits. Sometimes all clumps on a limited tract of country come into flower at the same time, at other times isolated clumps or groups of clumps produce flowers and seed, and frequently some stems of the flowering clumps bear leaves.

Of this class, the best known example is *Dendrocalamus strictus*, that species, which is one of the few Bamboos, with a wide range of distribution, being indigenous not only in the Western and Eastern Peninsula, but also in Java and other islands of the Indian Archipelago.

In Burma, where it is known as Myinwa, and where it generally is the prevailing species, in dry localities, this kind often flowers gregariously over extensive areas, while on the outer hills and in the outer valleys of the North-west Himalaya, isolated clumps or groups of clumps are more commonly found in flower. Mr. Gamble (p. 79) mentions the following instances of the gregarious flowering of this species in the Western Peninsula :—

1865	in the Central Provinces.
1870	„ Garhwal.*
1880	„ Oudh.
1887	„ Kurnool.
1890	„ Golconda Hills, Vizagapatam.
1891	„ North Arcot.

A curious instance of the successive flowering of this species in a series of contiguous localities is mentioned by A. F. Broun (I. F. XII, 414.). In 1883 the seeding began in the South-east corner of the Dún, then in 1884 turned the corner of the Siwaliks at Hardwar and continued in a North-westerly direction in 1885 and 1886, when, according to a communication since received from Mr. Gamble, it stopped in the Rauli Block.

One or two other species of this genus belong to the same class with regard to their flowering and seeding. *Dendrocalamus Hamiltonii*, Nees et Arn. a remarkable species of Nipal, Sikkim, Assam, and the Upper Irrawaddi near Bhamo and Katha, easily known by its thick over-hanging stems and purple flowers in a huge panicle, generally flowers sporadically, but at times gregariously, as reported by Gamble (p. 86)

*In the 'Indian Forester' II. 89, R. C. W. reports a general seeding of Bamboo in 1872, on which the chief Forest Revenue of his district depended. Species or name of district are not given, but the province probably was Bombay and the species *Dendrocalamus strictus*.

in Sikkim and Dehra Dún (where it is extensively planted near villages) in 1894.

Dendrocalamus longispathus, Kurz, of Silhet, Chittagong and Burma, easily recognized by the large papery culm sheaths, densely clothed with black stinging hairs, whence the Burman name Wa-ya, probably belongs to the same class.

Cephalostachyum pergracile, Munro, the Tin-wa of Burma, which extends North as far as the Naga Hills in Assam, and is probably also indigenous in Chota Nagpur, I have often found in flower both gregariously and sporadically in Burma. Here it is very common, but does not form as extensive forests as *Bambusa polymorpha* and *Dendrocalamus strictus*. In my paper on the Ringals of the North-Western Himalaya (I. F. XII, 203), I classed this species with *Bambusa arundinacea* and *polymorpha*. This, however, was a mistake. I have found it in flower in 1859, 1861, 1862 and 1880.

Arundinaria falcata, the low level Ringal of the North-Western Himalaya, certainly belongs to this class. Like *Dendrocalamus strictus*, this species at times is found flowering sporadically, while at other times it flowers gregariously over large areas. Thus (Indian Forester XII, 414) A. F. Broun states that in 1886 this species was in flower all over the hills of Jaunsar and Tehri Garhwal and that wherever he found it, almost every culm was loaded with flowers. Gamble (p. 13) says "It has 'been frequently found in flower, and though, as happened in '1879, years of general seeding are of occasional occurrence, 'a few clumps may be found in flower in almost any year."

Of *Ochlandra travancorica*, Benth., a gregarious species of the higher Ghâts of Travancore and Tinnevely, Bourdillon reports (I. F. XIII, 579) that it seeded in 1875, and again over the same area in 1882, so that its period of flowering seems to be seven years. This Bamboo, however, also flowers sporadically. In February 1882, I found culms with leaves and flowers on the Tinnevely Ghâts. Hence I am disposed to place it among the irregularly-flowering species. As already mentioned, another species, *O. stridula*, which is gregarious in Ceylon, according to Dr. Trimen, flowers annually.

Several species of *Arundinaria* probably have the same habit of flowering, at times sporadically and at others times gregariously and periodically.

Of several species which at times flower gregariously and at other times sporadically, particularly of *Dendrocalamus strictus* and *Hamiltonii*, and of *Cephalostachyum pergracile*, Gamble records (p. 109, and Introduction p. 8,) that the seed produced at the general flowering is usually good, while that given in the sporadic flowering is often poor and of small quantity. This is a very remarkable and important point. Indian Foresters, who have opportunities for studying this

matter, would do well to make methodical experiments. The weight and the percentage of germinating seed of each species, the produce of general and sporadic seedlings, should be determined, and I would suggest that this research be extended to species which, like *Bambusa arundinacea*, as a rule flower periodically simultaneously over large areas, but of which, now and then, single clumps are found in flower.

It now remains to mention a few other remarkable facts relating to the life-history of the species which have been discussed.

DO OFF-SETS ALWAYS FLOWER SIMULTANEOUSLY WITH THE PARENT CLUMP?

When cuttings are taken from an old clump of *Bambusa arundinacea*, or of other species of similar habits and planted out, it is well known that such cuttings in regard to the production of leaf-bearing shoots, behave in the same way as seedlings. During a series of years they only produce thin whip-like shoots, and only after a series of years has elapsed, a full-sized culm is thrown up, which, as in the case of seedling plants, shoots up to its full length generally in a few weeks, has dry, leathery sheaths at the nodes, and only a few green leaves at the top, the branches not appearing until several months later. Mr. S. E. Peal, in his interesting letter to the "Indian Forester" (VIII, 50) describes the development of the Jati Bans in Assam (*Bambusa Tulda*) from off-sets. In the second year, he says, the first whips may be 16 ft. high and an inch thick, nearly solid; the shoots of the third season may run up 30 ft. and be 1½ or two inches thick in the stem, while the shoots of the fourth year are often full size.

An important statement, which Mr. Peal makes may here be incidentally mentioned, viz., that when off-sets are taken, it is only the young, one or two year old full-grown stems, that throw up fresh stems from the rhizome, older ones being nearly useless for propagation by off-sets.

As will presently be explained, the large *Dendrocalamus* in Burma takes a much longer time than *Bambusa Tulda* to produce full-sized culms from an off-set. In this point the off-sets of all species behave alike, that, like seedling plants, they only throw up whip-like shoots during the first years of their separate existence, that is, until the rhizome has acquired sufficient strength to produce full-sized stems.

In the matter of flowering, however, off-sets behave altogether differently from seedlings. Wherever a general flowering of *Bambusa arundinacea*, for instance, has taken place, all off-sets,

which had previously been taken from the parent clumps, invariably come into flower simultaneously with the parent clumps. Nor does this seem to be unreasonable, for that portion of the rhizome, which has been cut off and planted out, possesses the same ability and has the same disposition to produce flowers and seeds as the parent stock, though it has not the strength to produce full-sized stems.

A remarkable report, however, of a plantation of the large *Dendrocalamus* (Wabo) at Myanoung on the Irrawaddy river, published in "Indian Forester" II., 311, called *Dendrocalamus Brandisii*, but possibly *D. giganteus*, seems to imply that there may be exceptions to this rule. The writer, who signs himself A. C. F., describes a plantation of this species above 20 acres in extent, divided into blocks of half an acre to two acres, belonging to different villagers. The cultivators state that this bamboo flowers and dies at the age of 40 years, and in order to guard against the destruction by flowering of the bamboo resources of the whole area, they dig up a small portion of the stock, with a shoot of the year, and plant it in the beginning of the rains; and, though the rhizomes of both bamboos are of the same stock, the mother tree will flower and die long before the young plant. The writer adds that in the first year the off-set produces the small whip-like shoots, similar to those springing from bamboo seed, and that after seven years the culms produced by the rhizome attain a girth of 10 inches and a height of 40 ft. Shoots of this size are saleable, but it is not until the clump has reached an age of 15 to 16 years, that mature shoots are obtained.

It would be a matter of very great interest to ascertain, whether this remarkable exception really holds good in case of the Wabo. According to the writer's account, the plantation at that time was extremely profitable. He found 15 to 20 yielding clumps per acre, and states that when mature, all three years' old shoots are annually cut, each clump yielding three to four shoots, the amount paid to the cultivator being 20 annas for the largest, and 4 annas for the smallest. Assuming 12 annas as an average price, such a plantation in 1876 would have yielded an annual income of between 40 and 50 Rupees an acre.

The demand for large-sized Bamboos in Pegu has doubtless greatly increased and the price has probably not gone down. Most probably, therefore, such plantations still exist, where the state of things could be ascertained. Indeed, there seems no reason why the Forest Department should not, in the vicinity of one of the larger rivers establish such plantations of the gigantic species of *Dendrocalamus*. Such undertakings would pay and would furnish excellent opportunities for studying the life-history of the species.

FLOWERING OF MUTILATED CLUMPS.

Another remarkable fact, which is mentioned by Mr. Gamble on several occasions, is that when a clump of one of the periodically-flowering Bamboos is mutilated or injured, it produces flowers before its time. This he mentions in the case of *Bambusa Tulda* (p. 31) and *nutans* (p. 33). Lately I had the privilege of discussing the matter with him, and he has given me the following additional information. In 1892 a clump of *Bambusa Tulda* near Calcutta was blown down, the mass of rhizomes was torn out of the ground, and the culms were mostly cut. In 1893 the rhizome brought forth numerous thin twigs with flowers; these, however, produced no perfect seed. The last year of flowering of *Bambusa Tulda* in lower Bengal has, as already stated, been 1884. Again of *Bambusa nutans*, a bush was found near Dehra Dnn in 1893 on the edge of an embankment, with the rhizome exposed and the stems cut off. The rhizome had produced a number of flowering twigs, which, however, did not produce any perfect seed. The last general flowering of that species had, as already stated, been in 1840; in 1894, however, Mr. Gamble found another bush (not mutilated) in full flower.

This is another of the many interesting facts in the life-history of Bamboos, which demands further research. The practice of slashing the bark of apple trees in our orchards, in order to induce them to set fruit more freely, presents some analogy with the mutilation of Bamboo clumps.

I will here mention a fact which has often been discussed but has not, as far as I know, been established by accurate observation. When I witnessed the first general flowering of Bamboos in Pegu, my Burman friends stated that such an event could with certainty be foreseen, for during the year preceding the flowering, no new culms were formed. This fact, which is generally accepted in Burma, nevertheless requires confirmation by a series of systematic observations.

DOES THE RHIZOME ALWAYS DIE AFTER
FLOWERING?

It has already been mentioned, that, after the seed has ripened, the culms which had only produced seed and no leaves, perish. A different question is, whether in the case of the periodically-flowering species the entire clump, that is, the rhizome, perishes. In many cases this doubtless happens, particularly for those species which, as a rule, only flower gregariously and periodically, such as *Bambusa arundinacea* and *polymorpha*. The matter probably is different in the case of those kinds which, like *Dendrocalamus strictus*, often flower sporadically and in that case generally have either a few leaf-bearing culms, or a few leaves on the flowering culm. In such cases the rhizome probably often remains alive.

The question is discussed by Munro in the introduction to his Monograph (page 3), and he quotes Dr. T. Anderson, formerly Superintendent of the Botanic Gardens in Calcutta, in words to the following effect:—In 1857 and 1858 many of the Bamboos near Calcutta and on Parasnáth flowered and seeded, but in no case that Dr. A. was aware of, did a general death of the bamboo follow. So far as he observed, only the flowering shoots died; and their place was taken by young shoots springing from the roots; but during the flowering and seeding the foliage almost entirely disappeared. Anderson adds, that when the *Bambusa gigantea* at Calcutta, after 30 years, flowered for the first time in 1891, the plants, although weakened, remained alive.

This most important statement relates to three or four species. First, *Bambusa Tulda* near Calcutta. It has above been stated, that in regard to its flowering habits, this species possibly may belong to the group of *Dendrocalamus strictus*. Second, *Dendrocalamus strictus* and possibly a second species, *D. sericeus* on Parasnáth. Third, *Dendrocalamus giganteus* (*Bambusa gigantea*) at Calcutta. These three or four species all belong to the class of irregularly-flowering Bamboos, and the species of this class, as far as we know at present, do not necessarily perish at flowering.

In the paper previously quoted (I. F. XII, 413) A. F. Broun gives an instance which agrees with my own experience. Near Dehra Dun, he reports, a clump of *Dendrocalamus strictus* flowered in 1881, and sent forth new, but thin shoots, in 1882. It then flowered again in 1885, and now, (1886) new scraggy and thin shoots are pushing up in the midst of the old clumps.

In the same communication, however, Broun also gives a remarkable instance of *Bambusa arundinacea*. "In Dehra" he says, "most of the clumps of this species died down immediately after flowering in 1881, but I know one case which proved an exception. In 1882, one clump sent up a number of new culms. These, however, flowered again during the present year (1886) and there is as yet no sign of new leaf-bearing culms coming up." Mr. Jasper Nicholls mentions a similar case (I. F. XXI, p. 92). In 1885, the Katang Bamboo had flowered and seeded in Rajim in the upper valley of the Mahanadi river. In 1886 all the clumps had died off, but "here and there was to be seen an exceptional stalk, and a few attenuated and almost abortive shoots had sprung up from moribund roots. These were striving to flower and seed." Twelve years ago, in March 1886, I permitted myself to draw the attention of Indian Foresters to this point (I. F. XII, p. 203). I think I may be excused for once more placing this question before them.

SEEDLINGS OF DENDROCALAMUS STRICTUS IN FLOWER.

Those who have had the patience to read this lengthy paper, will now be rewarded by the account of a truly sensational event, the flowering of a seedling plant of *Dendrocalamus strictus*. The history of this remarkable plant has been recorded in a Report by the Conservator of Forests, Patiala State. This report shows, that in June 1894 the seed was collected in the natural forest on dry, stony, South and South-east slopes of the outer hills near Kalka; that it was sown in the nursery at Pinjour in the beginning of March 1895. In February 1896, the plants were taken out and planted in baskets, prior to their being permanently put out into the forest. In April 1896, out of the whole lot in the baskets, five plants commenced to flower, two of these were sent to the Dehra Dún Forest School and received there in August, 1896. The remaining flowering plants were kept at Pinjour, when they died one after another within three or four months. A photograph of one of the plants sent to Dehra Dún, taken by Mr. Gleadow, is reproduced here* and shows the appearance of the plant. The following is a translation of the Conservator's Report.

1. "The seed was collected in June 1894 from natural 'Bamboo Forests growing on South or South-east slopes of dry, 'stony, lower Hills of sub-Himalayan tracts, belonging to the 'Patiala State, at from 1 to 6 miles to the North-west of Kalka, 'and 2,000 to 3,000 feet in elevation.

2. 'These Bamboo Forests have only one species of Bamboo, 'which is the common male Bamboo (*Dendrocalamus strictus*).

3. 'About 15 seers of the above seed was sown in State 'Forest nurseries at Pinjour gardens (3½ miles S. E. of Kalka) 'in the beginning of March 1895.

4. 'In February 1896, all the Bamboo plants raised from 'above-mentioned seed and in the above-mentioned regular 'nurseries, when about one year of age, were transplanted into 'baskets 5 or 6 months prior to their being permanently put 'into the plantations, on the bare dry Patiala Siwaliks during 'the next coming rainy season. At the time of transplanting, all 'the plants were healthy.

5. 'In April 1896, out of the whole lot of young Bamboo 'plants in baskets, five Bamboo plants commenced to flower. Two 'plants out of five were sent to the Director of the Imperial 'Forest School, Dehra Dún, through P. Madho Ram Patiala 'student at Dehra, and three were kept at Pinjour, where they 'died one after another within three or four months.

PATIALA, }
7th April, 1897. }

P. SUNDER LAL PATEAK,
Conservator of Forests, Patiala State.

*See Frontispiece.

One of the flowering plants, the original of the photograph, is now before me. As already stated, it was thirteen months' old when it commenced to flower, and it was received at Dehra Dún when one month old. The rhizome is much more strongly developed than is the case in the 12 months' old plants raised at Dehra Dún described above. On the left side are the stumps of two primary shoots, which have died and dried up. At the end of one bent rhizome branch is the first stem, bearing flowers instead of leaves, while the second and slightly thicker stem is at the end of the second rhizome branch, which likewise is bent, but is much longer and stouter than the first. It is 2 inches long, and at the bend nearly half an inch in diameter. It may be remembered, that the long rhizome branches are a peculiarity of *Dendrocalamus strictus*. The remarkable feature in these flowering seedlings is, that they are nearly as thick as those of the 24 months' old plant received from Dehra Dún. It would almost appear that in the probably rich soil of the Pinjour nursery, some of the plants were induced by some specially favourable circumstance, to develop their rhizomes in an extraordinary manner, which caused these plants to produce flowers in the place of leaves.

In forwarding his report to the Director of the Forest School, the Conservator of Forests requested him to find out the extraordinary cause of the early flowering of these Bamboo plants. Mr. Gamble has most kindly transferred this request to me. At present I regret extremely my inability to explain this entirely exceptional and most remarkable case. So much, however, we may learn from it, that the action of the leaves on these five plants during the rains of 1895, was sufficient to create in them the disposition to form flower-buds in the place of leaf-buds, for the ends of the flowers which began to show themselves in April 1896, must have been formed in the previous autumn. The specimen before me has perfectly-formed flowers, generally two fertile ones in one spikelet, the six anthers are full of pollen, and in the more advanced spikelets the ovary is stout, the ovule having apparently been fertilized. It would be interesting to know whether any of these five flowering plants had produced seed, and whether any of the seed produced by them had germinated.

Possibly, in such cases, the rule holds good which has been established by Mr. Oliver and Mr. Gamble, that Bamboos which flower out of their time, do not produce perfect seed.

CONCLUSION.

Indian Foresters may ask, what can possibly be the practical advantage of studying the life-history of the Bamboo in the

manner recommended in these pages. I fancy I hear some of my younger friends say:—"Were we to set to work to make experiments, to record our observations in the forests, and to publish the results, we should be put down as theoretical scientists, and that might interfere with our advancement in the service. For our own prospects it is much better to attend to business and to produce a large surplus revenue from the forests entrusted to our charge. We are practical men, and we desire to see a tangible result of our labours."

My reply is, that as a matter of fact, Bamboos produce a very large proportion of the surplus forest revenue in India, and that this proportion is certain to increase. The forests of *Dendrocalamus strictus* between the Sutlej and Sarda are probably at this time being worked to the full extent of their productive powers. Many millions of stems are brought down annually, in order to provide for the requirements of the plains of Northern India. If by more skilful management these forests could be made to produce larger quantities, there would be no difficulty in disposing of the produce. In Burma, at present, the more accessible forests yield all the Bamboos which the open country requires, but with the increasing population and increasing prosperity, the demand for Bamboos is growing steadily, and here, as well as in other provinces, the question of systematic management of Bamboo Forests must, in course of time, arise.

Nor ought we to lose sight of the Bamboo paper question. That question came up in India at the time of the Forest Conference of 1875; from that time until about 1882, it has occupied the attention of Indian Forest Officers, and has frequently filled the pages of the "Indian Forester." About 20 years ago, Mr. Thomas Routledge, of Sunderland, the chief agitator in this matter, himself came to India, armed with the best recommendations to persons in high and influential position. Rags had long ceased to supply sufficient quantities of stock for the rapidly growing requirements of the paper mills. Esparto grass had come into use on a very large scale, but even this new source of supply was insufficient to meet the demands of the paper manufacturer. In China, it was well known, excellent paper had always been made from Bamboo fibre. The prosperity of the British paper mills seemed at stake, hence the demand seemed justified that the Bamboo Forests of India should be thrown open to private enterprise, in order to save the starving paper mills. Fortunately, Indian Foresters in those days had studied the life-history of Bamboos, and they succeeded in convincing Mr. Routledge, that to collect the young shoots from the natural forests when they spring up in the rains and to transport them to the mill, would not pay. The question, therefore, of making over large areas of the natural forests to the

manufacturers of paper stock was not pressed, and the proposal was made instead, that Government should establish Bamboo plantations on a large scale, where, by means of manure and irrigation, the Bamboo clumps should be induced to produce larger numbers of fresh shoots, not at one season only, but throughout the year.

About that time, however, the manufacture of paper stock (wood pulp and cellulose) from Spruce timber had been developed mainly in Germany and Sweden, and the supply of this new material brought relief to the British Paper Mills. Wherever there are forests of Spruce and allied species, in Europe and in North America, the manufacture of paper stock from timber is progressing on a constantly increasing scale.

Nevertheless, Bamboo fibre is far superior for the manufacture of paper to Spruce timber, and there seems little doubt, that the Bamboo paper question is destined to be re-opened. As a matter of fact, Mr. Bourdillon reports (Gamble, p. 126) that the Iral or Elephant grass, *Ochlandra travancorica*, makes a splendid paper, and that a paper mill in Travancore uses it almost exclusively.

Hitherto it has generally been assumed that Bamboo paper can only be made from fresh shoots while soft, and before they are hardened by the deposition of silica. There seems no doubt, however, that in China the dry stems also are used for that purpose. Whether, on account of the large quantity of chemicals required, this may be commercially feasible in the case of the Indian species or not, the manufacture of Bamboo paper has a future in India. The question, whether the production of fresh shoots can be stimulated by manure and irrigation, and whether the removal of these fresh shoots will not weaken the productiveness of the rhizome, ought to be studied beforehand so that, when the Bamboo paper question again becomes pressing, Indian Foresters may have at their disposal the needful knowledge and experience. People who pride themselves on being practical, may be disposed to fight shy of work which is not likely to pay immediately. In the case of Bamboo they will further their own interests by looking ahead a little. Knowledge is power in this as in all other matters, and a thorough study of the life-history of Bamboos will pay in the end.

Wire rope-way.

The wire rope-way at Mount Stuart is intended to take small scantlings sawn at the mills, to the plains, whence they can be carted to the railway. It consists of one single large

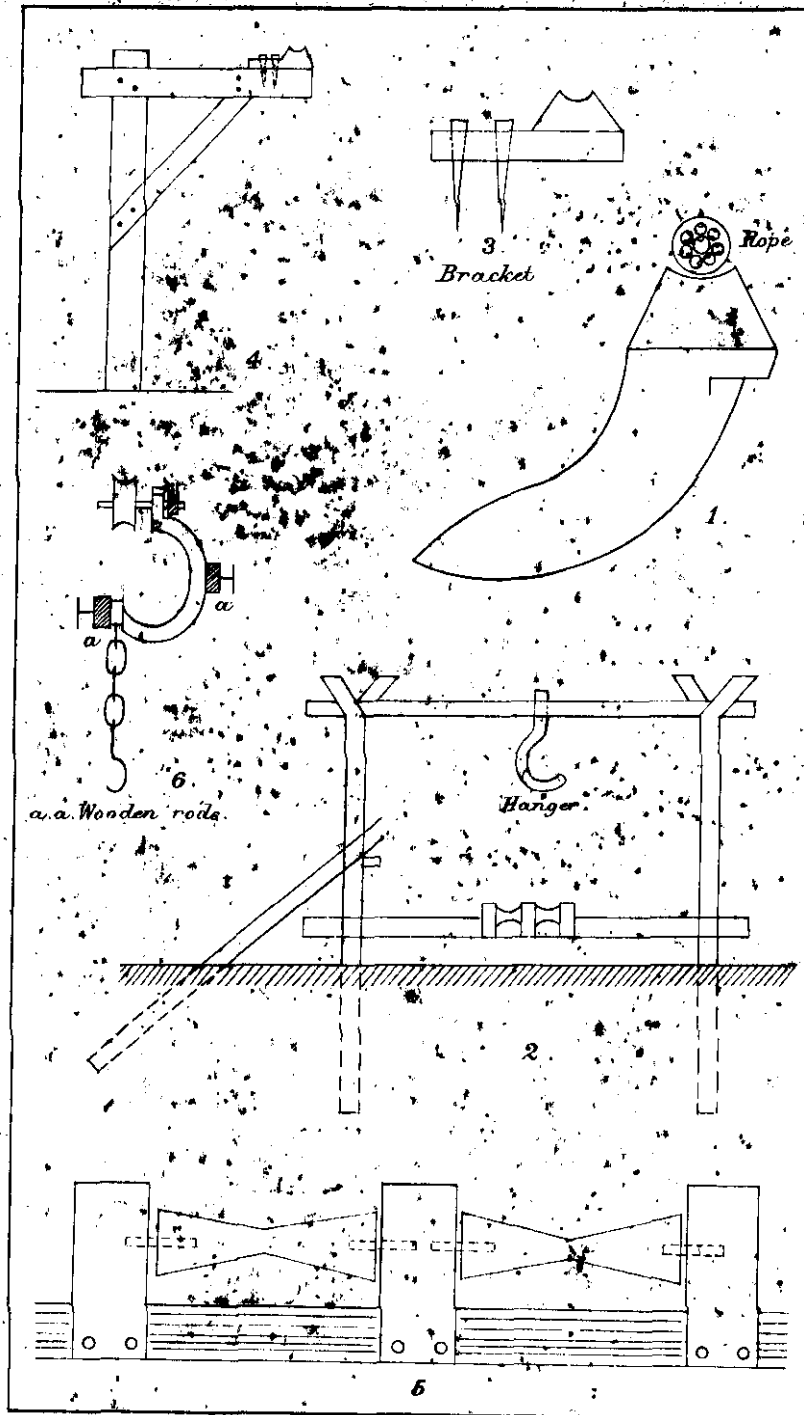
rope, carried on supports, anchored at both ends and provided with tightening gear at the lower end, and one endless hauling rope, passing round a wheel at the lower end, and round a brake drum at the upper end. Cradles travel up and down the single rope, clipped on to the hauling rope, the loaded cradle going down, hauling up the empty cradle. The maximum load for a cradle is $\frac{1}{2}$ a ton.

There is also a subsidiary rope, about 100 yards long, for conveying the scantlings from the tram trucks to the starting platform where the cradles are loaded. The length of the rope-way is a little over 6,000 ft., and the fall exceeds 1,000 ft.

The large rope came out on a huge reel; a strong iron axle was run through this reel, which was placed in position at the foot of the hills, the ends of the axle being supported on strong wooden posts, grooved for the axle to fit in, and firmly imbedded in the ground. A large body of coolies was collected, the idea being that a man should hold the rope every thirty or forty feet, so as to distribute the weight, and thus lay it out up the hill as it ran off the reel. But, owing to the unevenness of the ground this plan did not answer; when the head of the rope had progressed some distance, men further back, descending into ravines found the rope torn out of their hands and carried far over their heads; it is possible that if the leaders had halted occasionally there would have been sufficient slack to follow the lie of the ground, but the danger of kinking the rope would have been much increased; as soon as a wire rope gets at all slack, it folds over on itself, and unless the fold is immediately undone it is pulled into a twist or kink, which may seriously damage the rope, breaking some of its component wires. Three twists actually did take place, but were subsequently hammered out, and no permanent damage was done. As the distance from the reel increased, the power required to drag the head of the rope up also increased, and it eventually reached the top, hauled by seven elephants and a crowd of coolies; so great was the strain that if one or two elephants ceased pulling for a second, the others were all hauled backwards.

At the top, a huge rock had been placed in a pit, and an anchor bar fixed in the rock; a short cable was attached to the anchor bar, passed round the rock, and fastened to the end of the rope; the pit was then filled with stones and earth and a mound, 3 feet high, piled on the top of it.

The lower end of the rope was attached to a tightening gear consisting of one treble and one double pulley, one attached to a cable fixed to a rock in a similar manner to the cable at the upper end of the rope, the other attached to the lower



end of the rope itself; a small flexible wire rope ran through the pulleys, and power was applied by means of a winch fastened to beams let into the ground.

The tightening of the rope was a long and troublesome job, the tightening gear had to be laid out full length on the ground, the main rope made fast to it, and then the winch worked till the two pulleys had been brought close together; the main rope had then to be made fast to trees or logs, the tightening gear taken off it, laid out again at full length, again attached to the main rope and again hauled in; the operation had to be repeated two or three times in order to get the main rope sufficiently taut.

But before the rope was finally tightened it had to be placed on intermediate supports; the configuration of the ground made it impossible to have one long span, as the ground descends in gigantic steps. At the upper end of the rope, it was passed over supports on a platform 34 feet above ground level, in order to ensure a sufficient fall to give the cradle a good start; below this platform it was supported at intervals either on hangers, or on brackets; the former being of cast iron in the shape of a large G., the upper end being provided with a loop through which a pole could be passed, while on the lower lip there was a raised groove for the rope to lie in, with bevelled sides, to allow the grooved wheels of the cradle to pass (Fig. 1). These hangers, fixed on poles, were raised to the required height either on forks of standing trees, or on long stout poles firmly set into the ground and strengthened when necessary by side-props (Fig. 2).

The brackets were also of cast iron and consisted of the groove with bevelled sides described above, on a projecting base with nail holes in it, (Fig. 3) these were fixed on the top of gallows arms, either nailed to standing trees, or to posts firmly imbedded in the ground (Fig 4).



The height of these hangers and brackets above ground level varied from 7 to 35 feet. Every one of them had to be carefully adjusted exactly in the line of the rope, and as the rope did not behave exactly as was expected, several changes in the number and height of the supports had to be made after the rope was tightened; finally there were 25 supports in all, two of which were on bare rock, where the erection of posts was almost impossible; in these places double-headed rails were used for uprights fixed in holes cut in the rock, and held tight by Portland cement.

The hauling rope was taken up the hill in the same manner as the large rope, but being much smaller and lighter, only one elephant was required, and that only near the top;

had more coolies been available, the elephant's services could have been entirely dispensed with. This rope was passed over rollers, at intervals, and grooved wheels on the terminal platform; the rollers were of *Terminalia tomentosa*, about 18" long, 6" diameter at each end, and 3" diameter at centre, shaped like a dice box; they were arranged in couples, side by side, one to carry the up, the other the down hauling rope; for axles, they had 6 inch lengths of rod iron fixed at each end, half of the axles protruded and worked in holes in wooden blocks which were secured to a long rafter fixed to the uprights of the hangers, or to specially erected posts as required, care being taken to allow a six feet clear way for the cradle between hangers and rollers (Fig. 5).

The hauling rope, after passing over the platform, was passed four times round the brake drum, and then back on to the platform, where it was made fast to a cradle, and a couple of sleepers having been fixed on to the cradle it was thought that the weight would take the cradle and hauling rope down to the foot of the hills. But after proceeding about 15 feet, just enough to get a good strain on the rope, it stopped, and it was only by means of much hauling and pulling and shouting that it was induced to descend by slow and jerky stages. There were two reasons for this; (1) it had the whole weight (81½ lbs.) of the up hauling rope against it; (2) the rollers over which the up rope passed were unsatisfactory and gave rise to much friction; in fact the rope cut deeply into many of them in spite of the hardness of the wood. Eventually, the hauling rope reached the foot of the hills again, and then the two ends had to be spliced. A good splice is invisible and is the strongest part of the rope; it is thirty feet in length and is made by removing alternate strands from one end of the rope and laying strands from the other end in their places, finishing up by forcing 2 feet, 6 inches of each strand into the centre of the rope, in place of the hemp core which always exists there. The hauling rope had five strands, so three from end A had to be laid into end B, and two from end B into end A. Two amateurs spent a happy day over the job, and by evening the splice was made, but was not invisible, far from it, nevertheless it has proved itself capable of standing all the strain that will be thrown on it.

The endless rope was then passed over the wheel at the foot and the rope-way was ready for work, but the friction on the rollers, especially where there was a change from a gentle to a steep gradient, was so great that hitherto it has not been possible to work it; an improved kind of roller is to re-place the rough ones above described which will, it is hoped, enable the hauling rope to run easily. The fixing of

the spot at which the up and down cradles pass each other, and the erection of an arrangement to enable them to pass cannot be undertaken till the cradles run easily.

The brake drum consists of a horizontal wheel, 4 feet in diameter, supported on a wooden frame-work built into the ground; it has two flanges, one faced with wood, on which the hauling rope runs, the other of iron, on which the brake strap works; the brake strap is a long strip of iron with wooden blocks bolted on, iron and blocks being curved to fit half round the flange of the wheel; one end of the strap is bolted to the frame-work of the wheel, the other is connected with a lever, the depression of which presses the wooden blocks against the face of the wheel.

The cradle consists of two small deeply-grooved wheels, from the sides of which hang curved iron brackets, shaped like the figure 5; these are connected by wooden rods or bars which carry the screw clips for fixing on the up or down hauling rope. From the toe of each bracket hangs a short chain about three feet long which is tied round the load (Fig. 6).

The turning wheel at the foot of the rope is merely a large iron wheel, 5 feet in diameter, with a deeply-grooved face; it is mounted in the same way as the brake drum above described, and like it, has two small guide wheels to keep the hauling rope in place. During thundery weather any one touching the hauling rope is likely to receive an electric shock; several have been felt already, and though not strong enough to do any harm, there is no saying what their strength might be in a bad storm.

F. A. L.

Nitrogen and Plants.

The Madras Mail gives the following report of a lecture on "Atmospheric Nitrogen in its Relation to Vegetation" delivered by Dr. W. J. Leather, Agricultural Chemist to the Government of India, at the College of Agriculture, Saidapet, on Tuesday last :—

The lecturer, in introducing the subject, thought it would be as well to set out briefly the reason why it occupied, and still occupies, an important place in the field of agricultural research. Early in the history of chemistry it was determined that all plants were built up of two distinct classes of substances, one of which became dissipated on heating, while the other did not. The composition of the latter, or mineral, portion was only accurately determined later on, but it was readily recognised that the plant must rely entirely on the soil for a supply of its mineral ingredients. Regarding the portion which was dissipated on heating, it was discovered last century that this portion consisted of compounds of carbon, hydrogen, oxygen and nitrogen : and it has been known for over half a century that plants obtained the greater portion, if not the whole, of their carbon and a part of their oxygen from the atmosphere, and that most of the water entered through the root, the supplies of these substances being practically unlimited.

The question was whether plants obtained their nitrogen from the soil or from the free nitrogen of the atmosphere. The first experiment was made in 1779 by Priestly, who, working with primitive apparatus, came to the conclusion that plants assimilated the free nitrogen of the atmosphere. Twenty years later De Saussure, as the result of his experiments, came to the opposite conclusion. In 1837 Boussingault investigated the matter with indecisive results, but he again attacked the subject in a more thorough manner in 1850 and subsequent

years. He grew plants from seed, in a soil which was capable of supplying the necessary mineral matter, but which did not contain any compound of nitrogen. The whole was enclosed in a large glass sphere, which was occasionally supplied with carbon dioxide, a supply of water being given to the soil. In this way the compounds of nitrogen were, as far as possible, put out of reach of the plant, while the free nitrogen of the atmosphere was in contact with it. His experiments showed that nitrogen in the plant was practically the same in amount as that originally contained in the seed—in other words that the plant did not assimilate atmospheric nitrogen. These results were subsequently confirmed by other experimenters, notably Lawes, Gilbert and Pugh, of whose apparatus and methods of procedure the lecturer gave a detailed account with the aid of the necessary appliances.

The question could not be allowed to rest here, for there was a generally expressed opinion among British farmers that clover, in addition to producing excellent crops of hay, enriched the soil for a succeeding crop of wheat or barley, and further that all competent investigators admitted that the question, in spite of the results already mentioned, was not fully solved, while some of the field experiments seemed to confirm the British farmers' opinion. Hellriegel and Wilfarth carried out a series of investigations on the relation which existed between the amount of plant-food in the soil and the weight of crop obtained. Plants were grown in sterilised soil in a series of pots having a good supply of plant-foods other than nitrogen. In one pot of a series there were no compounds of nitrogen present; in a second pot a small amount of combined nitrogen as sodium nitrate; in a third pot twice as much and so on. It was found that in the case of the *Graminaceæ* and some others, that the weight of plants produced depended largely on the amount of combined nitrogen supplied, but that with the *Leguminosæ* the yields varied. Further, the striking fact was demonstrated that pea plants, grown in sterilised soil, with no supply of combined nitrogen, in some cases grew luxuriantly, while in other cases their growth was limited to the supply of nitrogen in the seed. The roots of the stunted peas had developed numbers of nodular protuberances. The question was, therefore, raised, whether this phenomenon was in any way connected with the action of micro-organisms or microbes. Further experiments showed that the *Leguminosæ* did not thrive in cultivation pots from which all micro-organisms were excluded, that these plants developed nodules on their tubercles and thrived well if the cultivation pots were watered with muddy water obtained by slaking fertile soil with water, but not if this water was previously sterilised by boiling. The lecturer then described the experiments in detail and summarised the results as follows:—Plants belonging

to the natural orders *Graminaceæ*, *Cruciferae*, etc., did not assimilate atmospheric nitrogen; plants belonging to the sub-order *Papilionaceæ* (order *Leguminosæ*) assimilated atmospheric nitrogen if certain micro-organisms were present in the soil. The experiments of Hellriegel and Wilfarth have been corroborated by Lawes and Gilbert. The lecturer then proceeded to give in detail the evidence tending to prove that the nodules mentioned were due to inoculation, and said that certain bacteriologists had separated organisms from these nodules. Nobbe, it appears, has grown these organisms and has placed them on the market in suitable vessels ("Nitragin") so that soils deficient in the organisms may be supplied with them. Regarding the practical utility of "Nitragin" the information at present available seemed insufficient to base any opinion on the matter. The lecturer incidentally pointed out that some of the lower forms of vegetable life such as *Algae* and *Lichens* seemed to be capable of assimilating free nitrogen, which accounted for the phenomenon noticed by some observers that, land left apparently bare, showed an increase in the amount of nitrogen present. The question "in what way do bacteria assist certain plants in assimilating atmospheric Nitrogen" was answered by Lawes and Gilbert as follows:—"The alternative explanations of the fixation of free nitrogen seem to be:—1st, that under the conditions of the Symbiosis the plant is unable to fix the free nitrogen of the atmosphere by its leaves; 2nd, that the organisms become distributed within the soil and there fix nitrogen; the resulting nitrogenous compounds becoming available as a source of nitrogen to the roots of the plant; 3rd, that the free nitrogen is fixed in the course of the development of the organisms within the nodules, and that the resulting nitrogenous compounds are absorbed and utilised by the host." The third suggestion seemed the most likely one.

Leaving aside the purely scientific aspect of the question, the lecturer said he would like to deal with the practical side of it. It was true that through the agency of pulses the land became enriched to a certain extent for a subsequent cereal crop. But experiments carried out at Cawnpore and elsewhere showed that the root residue of a pulse crop could only be relied upon to increase the cereal which filled it by about ten per cent., which was very little compared with the increase which could be obtained by the use of nitrogenous manures. Doubtless the part played by pulse crops in India was an all-important one, but it would be folly to trust to such crops alone to replenish the soil and to neglect the use of cattle dung and other manures supplying nitrogen to the soil. The soils of India were very poor in nitrogen; and this left only one conclusion to be drawn, namely that, although our pulse crops were annually assimilating some nitrogen from the

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atmosphere, the amount so brought into combination with the soil was not sufficient either to increase naturally the store of this all-important plant food, or even to maintain it at a high level.--(*Planting Opinion.*)

The Cultivation of Citronella grass in Ceylon.

The production of citronella oil has increased so enormously during the past few years, that Messrs. Schimmel & Co., of Leipzig, have found it necessary to undertake a more complete study of the cultivation of the grass and the preparation of the oil in Ceylon, than has hitherto been made. (*Schimmel & Co.'s Semi-Annual Report, October, 1898*).

The grass is cultivated exclusively in the southern province of Ceylon, mainly between the rivers Ginganga, in the north-west, and Wallaweganga in the east. The present extent of the plantations is from 40,000 to 50,000 acres of land. The grass grows in tufts, to a height of about 40 inches, and only on the declivities of the hills. The plants require but little care; the harvests, however, must be gathered regularly, and in due time, as otherwise the spikes grow too luxuriantly, and partly decay. The crops are generally gathered twice annually, the first during July and August, the second during December and January. The former crop is the more remunerative, as native labour is then more available; it is also more productive, a larger yield of oil per acre of grass being secured. During December and January the rice fields have to be prepared for the south-west monsoon, which occurs during April and May, the result being that the hands are not always available for the citronella crop, and its harvesting has sometimes to be postponed.

The oil is obtained by steam distillation of the grass, without the addition of water, the yield varying from about 22 lb. to 28 lb. per acre for the summer crop, and from 7 lb. to 14 lb. per acre for the winter crop. The produce varies, also, with the age of the grass, the weather, and the local conditions of the various plantations. The yield of oil gradually decreases, and after about fifteen years the vitality of the grass seems to become exhausted and the raising of new plants becomes necessary to maintain the estate in a paying condition.

The distilleries are located at the base of the ridges and hill-sides, where cool water may be obtained in sufficient quantity. The distillate is kept under lock and key, since the natives cannot be entrusted with its care. When a sufficient amount of oil has collected, the proprietor bottles it, and allows the aromatic water to run away. Each distillation occupies

about six hours. The exhausted grass, after drying in the sun, is used exclusively for fuel, as wood is almost entirely absent from the southern province of Ceylon. As soon as the rainy season sets in, the working of the distilleries ceases, owing to the lack of dry fuel. The working expenses are small, as the wear and tear of the distilling apparatus is inconsiderable. The coolies employed receive $37\frac{1}{2}$ cents, the women about 18 cents a day.

Exact figures of the percentage yield of oil are not available, as the weight of grass put into the stills is never ascertained.

The total number of stills in Ceylon is about 600, producing annually about 1,000,000 lb. of oil. The export of oil during 1897 amounted to 1,182,867 lb., while the shipments for the present year, up to August 30, were 1,021,626 lb., as against 781,832 lb. during the same period of last year. Of this quantity, England has imported about 462,000 lb., and the United States 522,000 lb.

The citronella plantations in the Straits Settlements, near Singapore, are insignificant when compared with those of Ceylon. It appears that about 1,000 acres are at present under cultivation there. The oil obtained from that district, however, is of very good quality, and yields as much as 90 per cent. *geraniol*, the average yield being only from 60 to 80 per cent.—(*Imperial Institute Journal*.)

Connection between the roots and leaves of Palms.

I am sending you some samples of Sago Palm (Bot: *Caryota urens* : Telugu, "Bakinimannu," Uriya, "Solopo") collected from the Nallamalai Hills in the Kurnool District, where the species grows in great profusion in damp localities, covering the soil with a regular carpet of seedlings. From these specimens several points may be noticed. First: when one leaf is developed there is one root; when two leaves are developed there are two roots, and generally when three leaves are developed there are three roots, but sometimes more. There seems, therefore, to be a very intimate connection between the number of roots and number of leaves developed; it may be that, where the number of roots exceeds the number of leaves developed, more new leaves are developing. I send also (but regret it has been much damaged) a specimen of grass which has, or has had, 28 leaves developed and has 28 main roots; whether this is merely a coincidence I cannot say.

I send also a portion of a *Caryota* stem, from which I have cut the leaves just above where they separate from the stem. Each leaf completely surrounds the stem at the base of the petiole; in the samples of leaf sheaths herewith sent, I was obliged to cut the net-work of fibres, which was continuous all round the stem for from 2 to 4 feet in length, so as to take the leaf off the stem. One leaf is developed at each node, and between the nodes the petiole of the leaf forms part and parcel of the stem. In the Kistna District I found that 3 leaves were developed at each node in the Palmyra (*Borassus flabelliformis*), and in the date (*Phoenix sylvestris*) even a greater number seem to be produced (I hope to investigate the date more carefully next month).

The stem of the *Caryota*, thus deprived of leaves, resembles a drawn-out telescope, the object glass of which is at the roots, and the eye-piece points upwards.

Referring again to the seedlings, it will be seen that the first root almost resembles the tap root of an exogen, but that the monocotyledonous formation is so distinct. The collum in the dicotyledon is an indefinite point between the cotyledons; in this, what corresponds to the collum (which term, though not Botanically correct in this case, I shall adopt) is a most distinct point. There is not the slightest doubt that at this point, the fibro-vascular expansion from the seed, the root, the first leaf and its sheath diverge. When the second root forms, it develops higher up than this collum point, and immediately below the sheath of the first leaf. The first leaf develops between its sheath, almost surrounded by it, and the fibro-vascular expansion from the seed, and is, therefore, in the middle of the plant. When the second leaf appears, the seed and its expansion have dropped off, and it comes from the base of the petiole of the first leaf, which forms a sheath for the second leaf and between the first leaf and the sheath of the first leaf. It thrusts the first leaf out of the central part and takes the centre of the plant itself. The third leaf acts in the same way to the second leaf, and the fourth to the third leaf, and so on, just as the second did to the first. The third root forms just below the first leaf, the fourth root below the second, and so on, the roots getting gradually higher and higher up above the collum point the later they develop. There seems to be a centrifugal tendency about these roots. This can be further observed from the fact that young palms have none of their roots above ground surface level; but, the older they become, the more such roots above ground appear; and in bamboos sometimes they are seen springing from the lowest two or three nodes above ground level, when the rhizome is fully crowded out. The same is seen in *Caryota* and *Borassus*, but ordinarily the nodes are not so distinct, and they seem to come out between the nodes.

Endogenous growth of wood is generally said to consist of a cellular tissue in the centre with a compact net-work of fibro-vascular bundles outside it, forming a rind. It was generally supposed that these fibro-vascular bundles came from the outside of the rhizome, passed in towards the centre of the stem, and passed outwards again towards the rind and into the leaves. A celebrated botanist (French, I think,) whose name I cannot just now recall, took exception to this, as it was found that tracing some of the fibro-vascular bundles back from the leaf, they passed towards the centre of the stem, then came back to the rind considerably higher up than the rhizome. I think an investigation of these specimens will explain the matter. The fibro-vascular expansion from the seed forms the fibro-vascular bundles of the first root; those of the first root form those of the first leaf and sheath, those of the sheath form those of the second roots and those of the first

leaf form those of the third root; and so the bundles are formed in succession from root to leaf and from leaf to root. In the mean time cellular tissue is being formed in the centre of the plant, kept there and prevented from expanding much outwards by the fibro-vascular tissue. As each leaf develops it takes the centre of the plant, forms a small portion of stem (between the nodes), and is then pushed on one side by the next leaf. As each root develops it takes a position more and more away from the centre, and higher and higher up the stem; but it must be remembered that above ground it cannot come out of the stem, *i. e.*, it must lie dormant until the sheaths of the leaves have fallen away from the stem. As the tree develops the fibro-vascular bundles have to pass from the side of the root (*i. e.* not the centre) to the centre of the stem when the leaf develops at the top and centre of the stem, and is pushed back to the side of the stem by the development of fresh leaves; and the more the stem increases inside, the greater will be the curve of the fibro-vascular bundles, until it is flattened by other bundles coming inside it.

It does not necessarily follow that, because the fibro-vascular bundle has to pass to its root, that it necessarily passes to the bottom of the tree; for the roots appear on the tree higher and higher up the stem, as the tree becomes older; and there must be many dormant roots which have been prevented from coming to the surface by the persistent sheaths of old leaves.

It seems rather curious that weight is attached to the difference in growth between endogenous palms and acrogenous Tree Ferns; for the difference seems merely in degree. Both consist of cellular interior tissue, with fibro-vascular exterior tissue; in the case of palms the fibro-vascular tissue from a leaf appears to descend to form a root before forming another leaf, whilst in the case of tree ferns it appears to ascend direct to form the next leaf. The rind of endogens is consequently far stronger and more continuous. The term acrogenous, too, seems to be misleading, for in the endogenous palms, each leaf comes to the central summit before being pushed aside by a new leaf; the same happens with the Tree ferns.

A. W. LUSHINGTON.

29th January, 1899.

Fire Conservancy.

In his interesting article in the 'Indian Forester,' H. H. invites correspondence on the subject of *Fire Conservancy*. The reticence of the Department renders the diffusion of

technical knowledge difficult and prevents the 'Indian Forester' from being as absorbing as it might be. This is my reason for hastening to accept the invitation by forwarding a few remarks tending to regulate the correspondence which, it is hoped, may arise.

As usual in Indian forestry the expenditure to be incurred on protection may in the first place be considered. We wish to insure our forests against special danger, the higher the premiums we pay, the fewer the risks we run, but the value of the forest must limit the amount of the yearly premium we are justified in disbursing.

Secondly, as to the method of insurance; we may invest our premium in preventing the outbreak of a fire or in limiting its extent; or we may have both these objects in view. That is, we may devote special attention to the protective staff or to an effective system of fire-lines, or to a combination of both.

But before deciding on the system of working, suitable to a specified area, we have to take into consideration not only the value of that area, but its position and aspect, the climate and local circumstances of isolation, remoteness from populated localities, or the reverse.

The ideas of fixing the width of fire-lines by the height of the grass, or of imagining that lines of any width will, save in the most fortuitous circumstances, arrest the progress of a fire have, I think, been long since abandoned. Lines are now acknowledged to be useful solely as bases from which operations, calculated to limit the extent of a fire, may be undertaken; they serve also to minimize the danger caused by railways and roads open throughout the dry season. This being the case, if we can afford it, it is best to have them clear cut and burnt; but, if our forest is of small value, rough fire-traces must be deemed sufficient for the purpose.

With regard to the width of fire-lines, we cannot provide for exceptional circumstances; on a still spring night we can counter-fire from a 10-foot road; in a breezy summer day our 100-foot line may become an uninterrupted sheet of flame. Here again the value of the forest must be considered. If we are working in coppice or improvement fellings, where a fire may mean the loss of one or several years' income, we are justified in expending large sums in insurance; and when the danger from fire is a constantly recurring one, we are right in exercising extreme caution; thus, where railways pass through valuable forests a 200-foot clearing might not be amiss.

The direction of the fire-lines will indicate the purpose of the designer of the system. If they lie at right angles to the prevailing wind direction, we shall know that the object in view was to arrest the progress of an advancing fire. In

this case they may be half a mile wide and yet fail in their purpose. If, on the contrary, they run with the chief wind direction, we shall know that they were intended as base-lines for limiting the spread of a fire to the area of one forest block by permitting judicious firing along its boundaries, which, in the first instance would not be feasible. Of the system of trained gangs of fire extinguishers, who might be employed in various light silvicultural duties when not engaged in their professional labors, I have no experience and speak with diffidence. Such a gang would be a valuable acquisition, if fire broke out in its immediate vicinity, but in large divisions the damage would be done before the gang arrived. I would suggest that, to acquire the necessary experience, the men should undergo a course of training in one or two divisions, which offer special facilities, and that, thereafter, the survivors might be made Cantains of the various salvage Corps throughout their Province.

Where large areas are under Fire-protection, it is absolutely necessary that the surrounding population should be interested in its success. The Forest officer has many ways of creating this interest. The watchers need not be numerous, but they must not be antagonistic to their surroundings. A watcher, within whose charge one or several unaccountable accidents occur, should be removed; there is probably some friction in his neighbourhood. In the same way subordinates, to whose call for aid the tenantry will not respond, are, in the majority of cases, unfit for their posts. In high timber forests in the hot season fires cannot be controlled by the forest staff, the help of outsiders must be obtained; but it is with suspicion that we note that these outsiders have much experience; it is preferable to find them willing in their ignorance to be led by an experienced forest officer. All watchers, save those immediately concerned, should stand fast when a fire is in progress, for it is the golden opportunity of the spiteful incendiary.

The tendency of these remarks is that, in discussing the points noted on by H. H., it should be clearly set forth what manner of forest we are referring to. Our ideal is an area yielding, say, Rs. 5 per acre per annum, divided into rectilineal blocks by broad lines covered with green sward, with a well-fed watcher in a suitable abode at each angle. At the other end we may have a forest bringing in no income, but costing a good deal for protection, where we must perforce be content with much less effective measures; but there can in no case be any doubting but that judicious outlay reduces our risk.

O. C.

Remarks on some forest topics in Burma.

The May number of the "Indian Forester" reached me when I was on a forest tour in Germany. The review on the Burma Forest Administration Report in it suggested many thoughts to my mind connected with forestry in Burma, but I was so much engaged at the time in making notes of the various interesting things we saw daily, that I had no time then to set those thoughts down in connected form.

The remarks quoted in the Review by officers on re-production are interesting, though apparently somewhat conflicting. As a matter of fact the re-production question resolves itself into three factors:—(1) a sufficiency of seed-bearers, (2) a due amount of light and (3) a proper condition of the soil. As regards (1), when seed-bearers are deficient, the only means to stock the ground with the desired species is by sowing or planting. As regards (2), we all know that the most important Burma species require a great deal of light for germination and successful growth. As to (3), the chief desideratum is an absence of a matted growth of grass and heavy weed, which is obtainable by keeping the ground well covered with tree-canopy and judiciously letting in light when re-production is required, in sufficient quantity for germination and growth of the young plant, and afterwards a further introduction of light from time to time till the young crop is able to stand by itself and suppress the weed with its own cover.

With reference to the observation, apparently taken from the Tenasserim Report, that teak seed grown in some portions of that part of the province "fails now to germinate, or if germinating, to produce healthy seedlings," there is no doubt that seed introduced from another country often succeeds better than local seed. At the same time it is probable that the failure of the local seed complained of, is attributable to the wrong conditions of light and soil rather than to the quality of the seed. In this connection I remember the very same complaint being made some years ago in regard to the teak seed in the Melghat Reserve, in Berar, yet, anyone now visiting that forest would be surprised at the great mass of young teak in many parts of it, most of which have sprung up in the last 15 or 20 years from local seed, produced by the most unpromising seed-bearers—ancient pollarded trees, full of defects from constant ill-treatment of every sort. The same thing is noticeable in the Ahiri and Bori forests in the Central Provinces, where the seed from old defective trees has produced wonderful results. These results have been brought about by continued protection from fire, grazing and haphazard cutting, which has gradually brought the soil and cover into favourable conditions for germination and growth. These forests were, for the most part, in a very

open state, when first brought under protection. The first consequence of protection was a growth of bushes and hardy species in patches, which suppressed the growth of weed round them, and it was generally around these bushes and on the edges of clumps of trees that the young teak at first succeeded in establishing itself. These islands of tree growth have gradually extended themselves and new islands are continually being formed, so that gradually the ground is becoming stocked, the stock being often principally composed of teak, frequently resulting in too pure a crop, so-much-so as to favour general and oft-recurring attacks from caterpillars. I think these examples of what the seed from old defective teak trees will do, show that it is probably not the seed, which is at fault in Burma. The fault is, in fine, to be found in the absence of one or more of the three factors mentioned above. In some cases it is due to excessive cover, of either tree or bamboo forest, more often the latter. Where it is due to tree-cover, judicious improvement fellings* are required, but, in the case of continuous bamboo cover, the chief means of introducing more useful growth must be by planting, and it is in such forests that taungya plantations are most useful and it is to it that they should be chiefly confined. In other cases, reproduction fails owing to thick weed and matted grass induced by a too open state of the tree-cover. With protection, such open places will gradually fill up, the weed will be killed, and they will in time come into a proper condition to stock with the most useful kinds, either naturally or artificially, as the case may be.

I am glad to see it stated that the great value of taungya plantations is fully recognised and that they are to be continued. I think, however, they should be continued on a well-considered plan, portions of forest to be stocked being scheduled and marked off on the map, so as to prevent the present somewhat haphazard planting, just as it suits the convenience of the taungya men. They should be principally made in bamboo forest and not as a rule in tree forest, unless the more valuable species are deficiently represented. It is deplorable, for instance, to see a fine forest, containing over 50 *Xylia* trees to the acre, destroyed to make a teak and catch plantation, such as it was my sad fate to see more than once in Burma.

In regard to the planting and weeding of taungyas in Burma, there are a few points which I should like to see altered. The planting is generally at 3 feet apart in lines 12 feet apart with the object of saving the cost of weeding. Now, as a matter of fact, there is absolutely no saving in weeding, as the whole area must be weeded, otherwise the enormous growth of grass and bamboo would soon suppress the young plants. It would be unsafe to leave any weed at all between the line. The resulting crop from this manner of spacing does not produce

* Or seed fellings rather. Ed.

nearly as well-formed young trees as those grown at equal distances apart, nor is the ground so soon covered. The young trees cannot develop their branches equally all round the stem; those at right angles to the line are greatly over-developed, whilst those in the direction of the line are quickly suppressed. The lower over-developed side branches do not become suppressed for many years, and when eventually they decay, leave ugly knots and wounds on the trunk which will result in defects in the heart of the future tree. Besides which, instead of a saving in weeding, this unequal spacing really causes an increased cost, for the cover of young plants does not close nearly as soon as with the regular 6 feet by 6 feet planting and therefore weeding has to be continued longer. There is besides an unnatural and premature decay of plants which would, under more favourable circumstances, continue to thrive and do their duty efficiently in covering the ground and suppressing weed. Thus, from all points of view, the regular spacing of 6 feet by 6 feet, is much to be preferred.

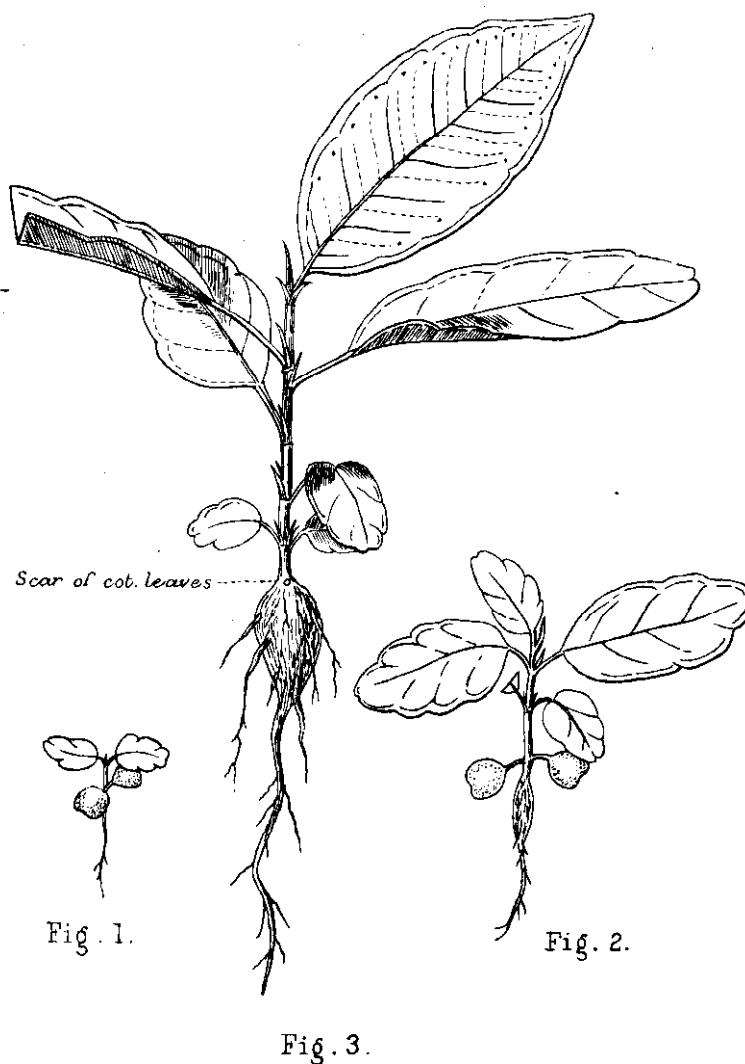
The weeding of the taungya plantations is a very important business and requires thoughtful and systematic management. When taungya plantations were first started, weeding was somewhat neglected, consequently some of the older plantations have now a rather patchy crop, but of late as system of weeding in each of the first three years (the first year's being done by the taungya men) and afterwards every other year, has obtained. This system has been pushed to such an excess that two years ago on my tour I found plantations of *15 years old, in which the teak saplings were 20 to 25 feet high, still being clean weeded*. Now it is quite evident that clean weeding carried on to such an age and state of crop are, not only unnecessary, but extremely harmful; for they prevent any formation of an understory of other hard-wooded species, so much needed for the protection of the soil, for which the light cover of teak is wholly insufficient. I am convinced from my observations of 3-year-old taungya plantations in Burma, that a fairly complete stock on ordinary good soil with regular spacing at 6 feet by 6 feet, if well weeded for the first three years, will have sufficiently closed up to dominate the weeds, and that, after that age, it will only be necessary to go through them, cutting down threatening bamboos and white woods every two years till 7 years old, and then again in the 10th and 13th years. In all these partial weedings, every care should be taken to preserve the other hard-wooded species growing *under* the teak, so as to encourage the formation of an understory for the protection of the soil. I know by experience how difficult it is to get workmen to discriminate between what they should cut and what they should leave, but this difficulty should not deter officers from introducing this most necessary reform. I was most pleased to see that, in the

Magayi plantations, a good deal of attention has been paid to this question, and that, in most of the older of them, there is a good deal of under-wood, which materially aids in the protection and improvement of the soil. Of course, it is much easier to attend to such matters in a compact block of plantations like that at Magayi, the care of which was the principal work in his range of the ranger, than it is in a large number of plantations scattered over a wide area, but I have no doubt that the difficulty can be got over by enunciating a well-considered scheme and impressing it on subordinates and workmen on every occasion, punishing the latter when they disobey by refusing to employ them in future or for a time.

In concluding these remarks, I should like to say a few words on the subject of raising teak in bamboo-covered areas. It has been proposed to prepare, immediately before any general flowering of bamboo, by collecting large quantities of teak seed, in order to sow up the flowered areas, but I fear that the chances of any great general success resulting from this proposal are not great. It will be too heavy and expensive a measure to clear and burn the bamboo stems over the immense areas that will be affected. It will, therefore, be only practicable to dibble in the teak seed in the flowering year, or, if possible, in the year previous to flowering and leave the resulting plants very much to themselves, for efficient weeding over such large areas, covered with falling and fallen bamboos, will be also out of the question. Any one, who has had to work or follow game in bamboo-seeded forest, will appreciate the difficulty of getting about in such conditions. Thus, the young teak plants must be left a good deal to themselves to struggle with the dense crop of young bamboo, which will soon appear, and a large proportion of them must succumb. No doubt after a few years we shall be able to go in and save the remnants by freeing them from the surrounding bamboos, but I do not think these will be numerous. At the same time it may be worth while to try the experiment, though I consider it would be unwise to base too sanguine a hope on the result. I think that a steady, well-considered plan of planting up teak taung-yas, dotted about in the midst of bamboo areas, while they are living or dead, will in the long run do more good than general sowings at the flowering epoch. Let us steadily continue to create islands of teak forest in the sea of bamboos, enlarging these as time goes on. It is a work of time, but every such island created is a lasting gain to the forest.

ALASSIO, ITALY :
15th December, 1898. }

F. B. DICKINSON.



FICUS ELASTICA, Roxb.

Fig. 1. About 10 days after germination.

Fig. 2. About 1 month after germination.

Fig. 3. Six weeks after germination.

All natural size.

Rearing India-rubber plants in Dehra Dun.

I received about 4 lbs of Assam India-rubber seed from the Director, half of which was sown in nursery beds, which were specially prepared with one part pieces of bricks, one part charcoal and one part dried cowdung well ground, on the 23rd April, 1898. This did not germinate till the end of the first week of June, 1898, *i. e.*, it did not germinate till the rains had commenced, although the nursery beds were well-watered and kept moist. Of the remainder of the seed, $1\frac{1}{2}$ lbs. were sown in nursery beds on the 7th July, 1898. The first lot of the seeds sown germinated well but the seedlings being very small and not able to catch hold of the soil, were washed away when the heavy moonsoon rains came. The second lot of seed began to germinate five days after sowing, but the seed was so light, that much of it was washed away. The remaining $\frac{3}{4}$ lb of the seed was sown on the 7th July, 1898, in 16 boxes and flower pots, and the boxes and flower pots were kept in the potting sheds, where they could get little light, in the School compound and fruit garden. The following was the compost in which the seed was sown in boxes and pots; one part, half-inch or smaller pieces of bricks, one part charcoal, half-inch pieces, and one part leaf mould with a little dried cowdung well ground for top dressing. The seed began to germinate five days after sowing and continued to germinate till the 15th August, 1898.

From the nursery beds I got 108 plants of India-rubber; the remainder of the plants and seeds were destroyed or washed away in the monsoon rains, though carefully protected with thatch. From the 16 boxes and pots I got about 1,600 plants, out of which about one thousand plants have been potted and basketed and about 600 plants, being very small, are still in the boxes.

From the above experiment I conclude, that India-rubber seed requires for its germination that the atmosphere should be well charged with moisture, so that the dry season is unsuitable. The best time, therefore, to sow India-rubber seed at Dehra is during the early part of July; it also germinates in August, but it is almost too late, as the whole of the seed will not be able to germinate before the atmosphere begins to cool, and also the young seedlings have not sufficient time to grow before the cold season begins. The sowing of the India-rubber seed in the open is objectionable, because the rain, either directly or indirectly, when tatties are put over the nursery beds, destroys and washes away the young seedlings and seed. The best way to grow India-rubber seed is to sow the seed in boxes and large flower pots in the compost mentioned above, and place them in potting sheds or verandahs, where they can receive a little light, and never to allow the boxes and pots to get dry. The watering

should be carefully managed, so that the young seedlings are not rooted out and the seed is not washed away.

BIRBAL.

The growth of the seedling. At first a pair of cotyledonary leaves appear, which are about one-tenth inch in diameter, orbicularovate, emarginate, dull green, minutely petioled. Above these come out a pair of opposite leaves. These are stipulate (as are also all succeeding leaves), slightly crenate, distinctly emarginate, membranous, with faint indications of arcuate nerves at the sinuses of an intramarginal vein, very shining above until superseded by the next leaf; one of the two leaves is somewhat larger than the other. Above these the leaves are sub-opposite when they appear, but soon become distinctly alternate by the elongation of the stem, each succeeding one larger in size than the one next below, and much brighter especially when fully grown. The fourth leaf above the cotyledons is about 1 by .6 in., ovate, distinctly crenate, emarginate. The next two leaves, the 5th and 6th, are oblong, 2 to 2.5 in. long, still emarginate, but the crenations are very shallow in the last leaf; lateral nerves 4 to 6 pairs, slightly arcuate. Then comes out the 7th leaf, all by itself, 3 by 1.2 in., oblong, with 6 to 8 pairs of parallel nerves and 2 to 3 intermediate ones between, no longer emarginate, but acute and almost entire, with a row of white glandular dots along the margins. This is the first leaf that reveals the identity of the plant. Beyond this the leaves become thicker and thicker, the 11th being about as thick as a normal India-rubber leaf. By the time the 5th leaf appears, a swelling is noticed below the root-collum, which goes on increasing in size, as is seen in Fig. 3. Neither *F. bengalensis* nor *F. religiosa* seedling has any swelling of this kind.

UPENDRANATH KANJILAL.

Notes on the Experimental Tapping of Rubber-trees in the Charduar Plantation, Assam.

Experiments in tapping 21 selected trees in compartments 2 and 3 of the Charduar rubber plantation during the years 1896-97, and 1897-98 the results of which are shown in detail in Appendix VI of the Assam Forest Report for 1897-98, gave a yield of 23 seers in 1896-97, and of 24 seers in 1897-98. The trees experimented on have been lightly tapped, and show no signs whatever of having suffered in any way; there appears to me, therefore, to be no reason to suppose that other trees in the plantation of similar age, the oldest experimented on being over 20 years and the youngest 17 years, would be damaged if subjected to similar light tapplings.

The compartments that contain trees not less than 17 years of age, that is, in which vacancies were finally filled up over 17 years ago, are Nos. 1, 2, 3 and 4. These compartments cover 318 acres, and contain 5,221 trees, as ascertained by actual counting; of these, alternate trees (say, 2,600) were over-tapped for three successive years in 1889, 1890, and 1891, with a view to killing them out, as the trees had been planted too close together to admit of proper development of their crowns, on which the full growth of a tree depends. It was found, however, that no amount of tapping affected the continued growth of the tree, and the opening out of the roots showed that all the

EXPERIMENTAL TAPPING OF RUBBER-TREES IN ASSAM. 71

trees in these compartments had become fairly anastomosed, or, in other words, that the plantation had become practically one huge tree.

The question now for consideration is whether the systematic light tapping of all the trees in the compartments Nos. 1, 2, 3, and 4 should be carried out every year, under the personal supervision of the Divisional Forest Officer and his Divisional Forest staff as an experiment, and with the view to Government's obtaining some present return for the expenditure incurred in forming the plantation. This expenditure from 1873-74, when work on the plantation commenced, up to 30th June 1898, amounts to Rs. 1,67,627, or Rs. 75-8 per acre for the 2,218 acres that had been planted up to that date, including 518 acres that were disforested in 1896-97 for tea cultivation.

The present value, taking it to be the cost debitable to the existing plantation, may be accepted as:—

	Rs.	Rs.
Total cost incurred up to 30th June 1898	...	1,67,627
<i>Deduct—</i>		
Value to be recovered for rubber-trees on 518 acres disforested, fixed by the Government of India at Rs. 89 per acre on 482.87 acres actually established	...	18,832
Expenditure that may be written off as incurred on the experimental stage, i. e., on learning how to plant rubber successfully, taken to be cost up to 1880-81 and partly up to 1882-83, up to which years almost all previous plants had to be replaced	...	34,000
Sales of rubber, seed, and seedlings, 1897-98	...	1,050
		<hr/> 53,882
Balance	...	<hr/> 1,13,745

which on 1,700 acres of plantation existing on 30th June 1898, equals Rs. 67 per acre. With the experience gained, it is estimated that future extensions will cost a maximum of Rs. 40 per acre.

Tapping lightly all the trees in compartments Nos. 1 to 4, including the 2,600 that it was attempted to kill out and the 21 that have been experimentally tapped during each of the last two years, may, it is expected at a *low* estimate, give the following results:—

Two thousand and six hundred untapped trees may be expected to yield annually an average of 1 seer per tree	...	Mds.	Srs.
	...	65	0
Two thousand six hundred and twenty-one tapped trees at $\frac{1}{2}$ seer per tree	...	32	30
Total	...	<hr/> 97	<hr/> 30

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say, 8,000 lbs., the cost of collecting which will be 8 annas per lb., or Rs. 4,000.

The value in London of the samples sent from the plantation tappings in 1896-97, through the Reporter on Economic Products to the Government of India, was 2s. 8d. per lb. The report on the value of samples (24 seers) sent to that officer, the result of tappings in 1897-98, has not yet been received.

Mr. W. H. B. Lawes, Superintendent, Bashwanta Tea Company, has kindly placed the following information at my disposal regarding the result of tappings of 121 rubber trees that were planted about the coolie lines of Dikorai garden, some 17 to 20 years ago, and have not been looked after, having been cut about from time to time by the coolies. These trees were lightly tapped by tappers supplied by the Deputy Conservator of Forests, Darrang Division, and rubber was shipped to London early in 1898.

Rubber obtained by tapping	...	...	...	lbs.
Rubber sold in London	...	...	...	180
				170
Consigned in London to Messrs. George Williamson and Company; realised in London on 170 lbs. at 3s. 3d. per lb.				
£ 27-12-6 (say)	...	...	415 8	Rs. As.
<i>Deduct</i> —				
Cost of tapping	...	...	90 0	Rs. As.
Freight to Calcutta, Re. 1 per maund (say)	...	...	2 8	
Freight, Calcutta to London, and other charges, £ 2-2-6 (say) 3 annas per lb. on 180 lbs.	...	...	32 0	
			124 8	
		Profit	291 0	

or Rs. 2-6-0 per tree.

From the above data and statistics it may be assumed that, taking the sale value of the rubber in London at 2s. 8d. per lb. as reported by the Reporter on Economic Products, the financial results of the annual experimental tappings proposed may be safely estimated as follows:

Sale value of 8,000 lbs. rubber in London at 2s. 8d. per lb., at 1s. 4d. per rupee	...	...	Rs.
			16,000
<i>Deduct</i> —			
Cost of tapping 8,000 lbs. at 8 annas per lb.	...	...	Rs. 4,000
Freight to Calcutta at Re. 1 per maund, say	...	...	98
Do. Calcutta to London, and other charges at 3 annas per lb.	...	...	1,500
			5,598
		Profit	10,402

which equals about Rs. 2 per tree, or on 318 acres, Rs. 32-11-4 per acre, and on cost per acre over nearly 50 per cent.

I have been somewhat diffident at putting forward proposals for systematic tappings for fear of eventual evil results on the capital value of the plantation as a property in which a considerable amount of Government money has been expended. I think, however, that, *given proper personal supervision by the Divisional Forest Officer and his staff*, the time has come when at least the experiment should be tried on the most mature area of 318 acres out of the 1,700 acres that have been planted up, and I therefore advocate, after having visited the plantation again, that action should be taken in this direction during the present tapping season.

DATED CAMP TREZPUR,

The 10th November, 1898.

A. L. HOME,

Conservator of Forests, Assam.

Forests and Water-supply.

Both in Europe and in America this question is receiving much attention, and as facts are of more importance than many theories, no excuse is needed for reverting to the subject in order that a knowledge of these facts may be as widely spread as possible. The *Revue des Eaux et Forêts* has two more articles on the subject; one from the pen of M. A. Mathey, the other from that of M. Ch. Broilliard, the valued friend and teacher of many Indian foresters. M. Mathey treats of Switzerland, and especially of Berne. Since 1868, this city has established water-works in five or six valleys containing springs with a more or less fluctuating flow, as follows, on the average of about 10 years :—

	Smallest mean flow. Litres per minute.	Date.	Greatest mean flow. Litres per minute	Date.	Annual variation.
Gasel	1,011	13 Jan.	4,154	Feb.	1 : 4
Schlieren	290	13 Ap.	784	Sep.	1 : 2.7
Scherlinthal	2,222	30 Sep.	1,5000	Sep.	1 : 6.7
Fier Moulin	882	14 Ap.	1539	Nov.	1 : 1.7
Brünback	1,765	11 Mar.	4,390	Oct.	1 : 2.5
Steinenbrüner					Small.

It will be seen that some of these springs vary in their yield more than others, and also, that the smallest yield occurs at different periods. For a town-supply, it is important that there should be little variation and that the time of minimum yield should be deferred as long as possible towards the next rainy season.

The Fier Moulin and Brünback springs are favourably situated, in that the greater proximity of high mountains causes the snow to lie longer and the rain to come sooner, but they are also protected by dense forest. Gasel and Schlieren being exposed to the South, have both been planted up and are well protected by forest, but Scherli is more open, having only one bit of forest high up. Its variation is greatest. The rains of the autumn of 1892 (1893 ?) caused the Scherli springs to flow at once, while Gasel showed little effect till January 1894, and Schlieren till April 1895. After the great drought of 1893, the Scherli springs, being unsheltered, reached their lowest level by September 30th, 1893, while the minimum flow was delayed at Gasel for 3½ months and at Schlieren for 6½ months. It is thus highly desirable that the Scherli basin should be planted up as soon as possible. M. Mathey relates, by way of a moral, an incident in which he took a leading part. In the Commune of Flacey (Cote d'or) is a small plantation. The Mayor was grumbling at the rate of growth and the small revenue, and even talked of cutting down the whole. The village brook was just below, and in flood, as it had been raining. A week previous it had run nearly dry. This was pointed out to him and he was presented with the suggestion that, so far from cutting down, he ought to plant up 200 acres in Wezy, dry Kimmeridge limestone, producing a rental of barely 2 shillings an acre. It then came out that at the beginning of the century this barren land had carried an excellent oak coppice, and that the full and regular supply in the brook was still held in remembrance. The planting of Wezy has actually begun, and the people of Flacey will long have cause to thank their Mayor and M. Mathey.

M. Broilliard takes us first to Russia and asks a question as pertinent here in India as there. The Russians have ascertained that in regions of very small rainfall (*e. g.* Deccan) forests lower, and lower considerably under some conditions not too clearly defined, the level of sub-soil water. Will they, the Russia

(or Indian non-forest officials), at once hasten to use the fact as an argument against having any forests there? Whatever may happen, or has happened here, the Russians will take good care to be led astray by no such error. They can see their vast rivers dwindling and silting up before their eyes. Our Deccan streams are already dry, and responsible officers calm their consciences by saying that it always was so, and must be so. But they do not know that it always was so, nor will any forest officer believe it.

The Chief Fire Warden of Minnesota, Mr. C. C. Andrews, has just published his annual report under the title "Forest, maintains water-supply," and his title is based, not on ideas but on solid facts. America is a young country, but its officials have no native press to be afraid of, and can look facts in the face. Fifty years ago the American naturalist, Henry D. Thoreau, wrote "The Maine Woods," in which he stated "the primeval forest is always and everywhere moist and mossy," and again, "the surface of the soil in the Maine woods is everywhere spongy and full of moisture." George P. Marsh, another reliable witness, wrote to the same effect. William Cullen Bryant also; "fifty years ago, large boats, heavy laden with merchandise, plied up and down the Cuyahoga river; now, a small boat or skiff is all that can pass, even in the lower reaches," (the American work not being available, the quotations are translated from the French, and will, therefore, not be the *ipsissima verba*). Both, Minnesota and the York States are feeling the diminution of water-supply. In 1884, New York nominated a commission of enquiry under Professor Charles S. Sargent to report on the condition of the Adirondacks. This mountainous plateau feeds several great rivers like the Hudson and Mohawk, and many small ones. The report stated that the influence of the forests was felt far beyond the limits of the State, and that their destruction would be followed by far-reaching commercial disaster. "The future of the rivers rising in the Adirondacks can be deduced from their past. Great changes have been observed since the forest area has been lessened. All the evidence obtained by the Commissioners goes to show that the summer yield of these rivers has diminished within the memory of man by from 30 to 50 per cent. Many little streams, which, 25 years ago had an abundant summer flow, are now dry for some months of the year. The flow is becoming more uncertain and irregular every year, and the losses by spring floods and summer drought go on increasing. All this is due to the destruction of forests, and the evil will increase if matters go on as at present. On the tributaries and head-waters of the Mississippi, the Sainte Croix, and the Red River, lumbering has been practised for the last fifty years, and in consequence of the destruction, the volume of water has diminished." Mauritius and Réunion are

arid spots in the midst of water, but only since their forests were destroyed. In St. Helena an important spring had dried up, but was restored by planting. Laboratory experiments are difficult to devise and of doubtful value, since they cannot be carried out under true conditions. Marshal Vaillant cut off a branch and placed the cut end in water. The evaporation from the leaves was prodigious, far more than the whole rainfall. The conclusion to be drawn is—*Nil*. A cut branch is not a growing tree, and a growing tree in some conditions is not like a growing tree in other conditions. The quantity evaporated is influenced especially by the quantity available. When the supply is small, the trees manage to get on with little. The pine, if water is plentiful, evaporates immense quantities, but it can also live on soils where there is almost none, *vide* the Southern and Western aspects of the Alps in the valley of the Durance. Even the spruce, which will grow in a marsh, nevertheless flourishes on the dry limestones of the Jura. The Eucalyptus has done good service in drying up swamps, but in Australia it frequently grows in places subject to terrible drought.

A good European case is that of the forest of Hardt, 35,000 acres, on Rhine alluvial deposits to the South-west of Mulhouse. The sub-soil is a great depth of coarse gravel and pebbles without capillarity, and the sub-soil water is down at Rhine level, some 45 ft. below the surface. A branch of the Rhine and Rhone canal passes through the forest, without a lock, for 12 miles. One fine day the bank burst and the forest was completely flooded. Within three days all the water disappeared, having sunk in at once to the 45 feet level. There is here no protecting canopy of high forest, only a coppice with standards consisting of oak, hornbeam, &c., on a shallow limestone soil with the great depth of pebbles below. The aspens die out at 20 years old, and the oak standards often die also when isolated, but the coppice, exploited at 30 years, is fairly productive. Now, here is a forest which certainly does not pump up water from 46 feet below. What can it evaporate? Certainly less than the annual rainfall, for much or most of this sinks in at once; yet the coppice remains complete. It is probable that after the abundant spring sap has fully formed the new leaf, the evaporation becomes quite small. If a branch is cut in the spring the section will wet the fingers, but if cut in summer it is barely moist. In the spring drought of 1893 the leaves withered on the trees, while in the summer drought just past, they remained perfectly green. Plants in pots give widely differing results; one experimenter even found that such plants evaporated a solid yard deep of water within the year. Mr. Samuel B. Green, Professor of Horticulture and Forestry at the Minnesota University, found that forest trees, evaporating less than agricultural crops, evaporate per acre from 500,000 to 1,500,000 pounds of water during the

season of growth, or a layer of 6 to 17 centimetres deep, say $2\frac{1}{2}$ to 7 inches. Ebermayer, a most competent observer, found that sandy soils allow to filter through them more water than falls on the surface. This appears an inconceivable marvel, but it may be accounted for on the supposition that the soil condenses moisture from the air. But whence does the air obtain it in a dry summer? Evidently from the leaves. Hence the same water serves over and over again. Here is food for reflection. A forest has mould, and thereby substitutes a sponge for a mere sand filter. Consequently, in regions of small rainfall, a forest is even more useful than where rain falls in plenty. The left bank of the Saone between Darney and Monthureux is covered with forest, the right bank is cultivated. Brooks enter the Saone from both sides, but it is not precisely the right bank which provides most of the water. These are all facts outside politics and their consideration may be recommendend to all whom it may concern.

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[No. 3.

The production of Sandal-wood.

The maintenance of a permanent supply of so valuable a product as Sandal-wood has been fully recognized from the earliest day of Forest Conservancy in India. It would have been strange indeed, if a wood, which sells at an average rate of some Rs. 300 a ton, had not been appreciated at its full commercial value. And yet there are no fixed opinions as to the best means of assuring a sustained yield, and there is a want of a definite policy by which alone the existing resources can be utilized to the best advantage, and a never-failing, possibly a steadily increasing, annual yield *can be* guaranteed.

The natural habitat of the tree (*Santalum album*) is circumscribed and there is no encouragement to propagate it outside the limits within which it grows naturally. Indeed, it is doubtful whether the wood of trees cultivated elsewhere is sufficiently rich in oil to be of commercial value.

Under these circumstances we can only look to certain districts of Madras, parts of Mysore, and the dry Northern portion of Coorg to supply the demand for Sandal-wood, and it is to the growing of the tree in these parts that our remarks will be directed.

The tree is well known to demand a comparative dryness of climate, where the rainfall is moderate (20-50 inches, *vide* Brandis's Forest Flora, p. 399.) and heavy clouds are not liable to give excessive moisture to the atmosphere, and to grow in poor soils composed of sufficient gravel to make them porous and consequently well drained. It is generally found at an altitude ranging from 2,000 to 3,000 feet. The young plant is extremely delicate and the tree is always shade-enduring. It is especially sensitive to fire, and is too often killed outright by it. Cattle and deer eat it ravenously and destroy large numbers of the young plants, which spring up profusely from seed, which is generally scattered by birds wherever the tree is common.

It is not found in dense forests of good growth, and affects only dry open woods of generally poor growth. It springs up much more commonly in hedge-rows, in clumps of *lantana*, and amongst shrubs, all of which afford it the requisite shelter and protect it from animals. It is rarer inside forests that have been reserved, than in and about cultivation, a fact which is perhaps due to a want of such undergrowth as would protect the plants from deer. It will be seen that the conditions requisite to its growth mark the Sandal tree as perhaps the most delicate of our forest trees, and it is small wonder that plantations of it have not altogether, and sometimes not even partially, succeeded. Still, some success has been attained, and for the future supply of the wood, we may deal with the three following sources.

I.—Trees near cultivation, in hedge-rows, on grazing ground or private lands.

II.—Trees in reserves, grown either naturally or by cultural operations aiding natural reproduction.

III. Trees in regular plantations.

The question arises as to how far and by what means the supply can be maintained from each of these classes of Sandal-producing tracts; and it is possible that the same answer may not be suitable to the different provinces of Madras, Mysore and Coorg.

I.—Trees near cultivation, in hedge-rows, on grazing ground or private lands.

In 1890, Mr. Hill, then Officiating Inspector-General, wrote in an inspection note on the Coorg Forests.

"The present supply of Sandal-wood, coming as it does from village lands, cannot be maintained from this source; for, although some reproduction takes place in the *lantana* hedges, the young plants are greedily eaten by cattle and goats, and the people regard them with anything but favour." Recently, the Deputy Conservator in charge has expressed the opinion "that he would rely mainly in the future for Sandal on those areas, protected forests and village lands, where the species grows best naturally, taking all possible measures to foster and protect all naturally-grown Sandal," and has proposed "that while strictly maintaining the present Government monopoly in Sandal, the ryot should be given a direct pecuniary interest in the growth of new, and in the protection of existing Sandal trees on his land."

This proposal is supported by Colonel J. Campbell-Walker, Conservator of Forests, in Mysore, than whom no one has greater experience in growing Sandal. He writes—

"I consider that every endeavour should be made to secure the thorough protection of areas at the disposal of Government containing a natural growth of the tree, and the cordial co-operation of owners or occupiers of private lands in encouraging and protecting its growth, which I would do by a liberal scale of payment for each mature tree uprooted."

~~In so far as village and private lands are concerned, it must~~ remain doubtful whether the owner's or occupier's interest can be sufficiently aroused by a promise of payment, 50 or 60 years hence, to make him think of either raising or protecting young plants in his hedge-rows. And trees which are out of reach of cattle are sufficiently protected by law, and no pecuniary interest in them seems to be called for. The only justification for such a concession to the ryot would seem to be the certain expectation that natural reproduction would improve, and the future supply of wood thereby increase.

As regards the protected forests referred to by Mr. Pigot, it is visionary to look for Sandal reproduction, so long as they are open to grazing and unprotected from fire; and if it is feasible to close them to cattle and ensure their protection from fire, there should be no objection to their reservation. As reserves only can they get the thorough protection advocated by Colonel Walker, and which Mr. Pigot doubtless allows to be necessary for the growth of Sandal. The desirability, however, of keeping up the supply of Sandal-wood from the first source cannot be gainsaid; and if the ryot can be induced to grow the tree on bunds and in hedge-rows, so much the better! We are somewhat sceptical of any very material results. On grazing grounds it is quite clear that only such odd plants as spring up under the protection of *lantana*, or thorny shrubs can survive and these must be in great danger from fire. Any areas at the disposal of Government which can be freed from grazing, must be available for reservation, and, as reserves, be capable protection from fire. It seems, therefore, that, notwithstanding that supplies have hitherto come from the first source, where, it may be admitted, the surviving trees seem to grow best, it is unsafe to trust to it for regular reproduction. There should, we consider, be no abandonment of it as a present supply, and every effort should be made to work it so as to make the supply as lasting as possible. It is, however, too Utopian, in our opinion, to look for a permanent supply of mature Sandal-wood trees from any open areas roamed over by cattle and goats, where the plants run the constant risk of being eaten, of being burnt by jungle fires, and of being hacked down by the villager.

II.—Trees in reserves, grown either naturally or by cultural operations aiding natural reproduction.

Colonel Campbell-Walker now writes.

"I do not assert that the tree cannot be reproduced artificially, *i. e.*, by regular planting, but it is difficult, and, in my opinion unnecessary, as the same or better results can be obtained by thorough protection of existing areas so as to secure natural reproduction, and by cultural operations in the shape of sowing and dibbling seed under existing growth."

Mr. Hill wrote of the Coorg Forests in 1890.

"The reserves * * * must be looked to for the supply of the future, and these reserves contain very few old trees and but little young growth. The natural young growth of Sandal in the Jainkal belt however, points to the conclusion that in the Northern reserves much may be done by cheap cultural operations to introduce Sandal in quantity over large areas, where fire-protection is assured and there is little or no grazing. In the Sandal belt there are scarcely any old trees and the young growth seems to have sprung up under favourable conditions of soil and shade from seed dropped by birds. These conditions seem to prevail more or less over the hilly portion of the Gangawara, Ganaguru, Alur, Nitda and Yodavanad reserves, where not grazed over, and, if this is the case, the systematic dibbling in of Sandal seeds would be followed by the best results."

The Coorg Annual Reports up to 1896-97 show that, while some 1,700 acres had been treated with dibblings or cultural operations, all except 100 acres of the previous years, and 400 acres of the current year had failed, and scarcely a single plant had survived. It is said that the want of success was due in one case to late sowings, in another to excessive rain. But the experiment does not seem to have been either carried out with care and intelligence, or to have been fully reported upon.

In Mysore, about one-third of 14,000 acres of plantations, classed as stocked, was treated by the planting of *Casuarina*, *Albizia* sp. and Sandal in pits. Neither the *Albizia* sp. nor the Sandal seedlings succeeded, only the *Casuarina* remained and this proved an excellent nurse for Sandal, which came up from seed, over the remaining two-thirds of the 14,000 acres stocked. Dibbling or sowing *in situ* has been carried on to a greater or less degree. On the whole it is estimated that 20 Sandal trees have been established to the acre over the stocked area.

In 1896, Colonel Campbell-Walker reported—

"The most gratifying results observed in the shape of Sandal growth under *Casuarina* were certainly in the Lakkasandra and Krishnarajpura plantations. These blocks have an aggregate area of 753 acres, of which about 400 are classed as stocked, containing about 1,00,000 *Casuarina* of different ages.

The planting of *Casuarina* was commenced in 1888, when a few nursery-raised Sandal seedlings were also put out, but did not flourish. Dibbling was commenced in the following year, so the oldest Sandal plants are seven years old, and some are certainly 18 feet high, with luxuriant foliage and a healthy and robust appearance generally."

Now, if Sandal can be raised in this way, with *Casuarina* as nurses, there seems to us no reason why it should not be raised from seed by dibbling in all fire-traced reserves, where the conditions of soil and climate are suitable. The necessary protection from cattle will be effective, and it will only become essential to regulate the over-head cover, or

any undergrowth that may exist to the degree of density required by the Sandal tree in order to make certain of success :—

Colonel Campbell-Walker considers that in dibbling, the soil should be loosened to a depth of at least one foot, in patches, 6 or 12 feet square.

He says the plants will not stand 'drip,' and that the cover should not be too dense. He considers a suitable shelter to be that of bamboos and thorny shrubs, or *lantana*, if kept under control. The squares, he says, should be previously prepared, and sowing should commence with the setting in of the S.-W. Monsoon rains, and be discontinued during breaks. He adds, that it is better to do a small area well, than a large area badly, and that he does not believe much good is done by desultory dibbling or scattering seeds broadcast. This advice is well worthy of careful notice, and, in our opinion, the success obtained under *Casuarina* should show the way to the general introduction of the Sandal into all suitable reserved areas.

These would then be a safe insurance against any falling off in the permanent supply of the wood. It should be remembered that, once the seedlings are established and have reached a few feet in height, it will be necessary to give them gradually more light, and possibly in due time to free their crowns entirely.

Colonel Campbell-Walker was once of the opinion that the Sandal, like the Oak in Europe, likes its head free and the ground covered.* It will, we need hardly say, be necessary to proceed with the greatest caution in exposing to light a delicate tree like the Sandal, especially when it has grown under cover for years.

III—*Trees in regular plantations.*

Up to 1896 the plantations in North Coorg, as a whole, were considered a success, and the then Deputy Conservator was of opinion that, judging from the older plantations, they would be well able to supply the demand after a period of 20 years.

Colonel Campbell-Walker has recently recorded that he does not think we can rely on the plantations for our future supply. Mr. Pigot reported last year on the Sandal plantations of Coorg as follows :

"Of the Sandal plantations or artificial sowings it may confidently be said that their present condition does not warrant their being counted upon to supply 120 tons (or even much less) of wood 20 years hence. Their condition on the whole is unpromising, and a considerable part of their total nominal area of 790 acres should be written off.

* I think it requires moderate high over-head protection but plenty of side-light, with the soil at the roots protected by herbs and bushes.—J. S. G.

Mr. Pigot further reports—

"It is said that the conditions of the plantations in 1890, afforded every promise of success. The change for the worse has happened since, and specially within the last two or three years. In 1890, there were no trees aged from 20 to 25 years, and it is amongst the older stems that disease and death are at present common."

Now, it is observed that, when Mr. Hill inspected the plantations in 1890, he found they had been weeded to excess, everything being cut close to the ground, and the isolated Sandal trees left like fruit trees in a well-grazed orchard. He wrote "Weedings must be steadily continued through the second and third years, and even later; but, *as the plants grow up, only such growth as is actually over-topping them should be removed.* How has the injunction, given above in italics, been carried out? Turning to paragraph 39 of the Annual Report for 1894-95 we find.

"Even Sandal itself cannot stand very thick *lantana*. Lately I have had a few lines opened through dense *lantana* where Sandal had been sown some five years ago, and which was known to have germinated excellently, and for two years was not last sight of. In these lines, for every one weedy Sandal, nearly a hundred dry rotted stems were found from three to four feet high."

Again Mr. Pigot says—

"Other areas, such as the Frazerpett plantation, have completely failed, owing, no doubt, partly to the spreading and vigorous over-growth of *lantana*."

Would it not seem that the bad condition of the plantations is due to the very mistaken idea that, the more Sandal trees are smothered with close, dense, dripping cover, the better they flourish?—Before the existing plantations are condemned and their extension is given up, it is incumbent on those in authority to satisfy themselves that failure, or the unsatisfactory condition of the trees, is not due to any of the following causes—

- (a) The choice of an unsuitable site.
- (b) The absence of nurses or a suitable shelter-wood.
- (c) Insufficient stocking in the first instance.
- (d) Destruction by fire.
- (e) Destruction by animals.
- (f) Injudicious weeding.
- (g) Neglect to weed.

but to the absolute inadaptability of the tree to regular plantations. It seems to us that if Sandal can be grown with *Casuarina* nurses, in chance squares (we should call them 'pits') as advocated by Colonel Campbell-Walker, the steps to regular plantation are simple and only two, viz., to adjust the shelter-wood so as to afford the protection given by the *Casuarina*, and to bring the pits into line at regular distances apart. Then, given plantations raised and maintained to maturity,

there would be a regular permanent supply of wood from a limited area, which could be easily protected and exploited, instead of scattered over wide lands which cannot be protected from fire and cattle, and over which the exploitation even is uncertain and surrounded by difficulties.

In conclusion, we disapprove of the idea of abandoning the attempt to raise Sandal in regular plantations, by which means the greatest quantity can be grown on limited areas. We strongly second the proposals to introduce Sandal by dibbling in seeds throughout reserves that are suitable for its reception. And, while we see no objection to encouraging ryots to grow the tree, we deprecate any reliance being placed on a permanent yield from any lands which cannot be closed to cattle and protected from fire.

Thinnings.

The following is a somewhat free translation of an article in the *Revue des Eaux et Forêts* by M. Broilliard, which cannot fail to interest his disciples and our other readers.

"A thinning consists in lessening the crowded condition of the crowns of the best trees in a canopy, so as to favour their development." Such was the definition I formulated in 1874, while touring in the high forests of oak in Central France. By great chance I came upon it while looking up a note on the Hardt, and I found it again amongst a few passing remarks noted on the exotics in the Park of Coucheverny, and on the staves and headers of Blois. Have I stated it elsewhere? Whether I have or not, this is the general idea that has guided me in the thousands of operations of the kind, which I have had to direct since 1854, and to-day it still satisfies my conception, though like every definition, it remains incomplete, and is even dangerous. Comparing it with others, starting from the stems to be removed, the idea is seen to be quite different. Let us see the application of it.

Among our forest trees the oak is the one, whose proper bringing up is the most difficult, notwithstanding the fact that an oak wood, left entirely to itself, may be sometimes a marvellously fine sight. For an instance, one has only to visit the Plantonneé wood, in the Tronçais district, if it still exists; nevertheless we cannot look on a lot of oaks, 200 years old, and only 50 cm. in diameter, while another lot of the same age are twice as thick, without enquiring into the mode of treating the latter. They are not so tall, of course. The former, with boles of 20 metres long, give about $2\frac{1}{2}$ m. c. of timber each, and are worth 100 francs apiece. The latter,

with boles of only 12 metres long, give $7\frac{1}{2}$ metres cubes and are worth 600 francs apiece. The one wood may contain two hundred of the smaller trees to every 50 or 60 of the larger ones in the other, but, apart from the money gain, the difference in quantity of material on the ground is not all loss, for many surplus stems will have been taken out in thinnings. There is no need for speculative argument, however; the fact is convincing. Slow-grown, soft-wooded oaks of 50 cm. diameter make poor planks, or, may be, a little wood for cooperage, whereas the trees of greater girth are good for every purpose. Let us thin out our crowded oaks, we shall in that way reap other advantages also.

A beech wood is constituted naturally, and, almost always as a dense crop, in which the stems lengthen and the crowns stretch up to even 50 metres from the ground, and almost always if the soil is deep, without risk of their future being compromised. But if left to itself, the beech forest, handsome as it is, does not turn over the capital, the value of the timber does not increase in proportion to its size, or anything like it, as happens with oak. Hence there is a general impression that beech high forest is a poor investment. In a general way, it is, but if thinned at short intervals, it gives a constant supply of abundant produce, even up to as much as half the current increment. These forests under timid foresters, so to say, are allowed to sleep, while in Denmark, under bolder hands, they realise 5 to 6 m. c. in thinnings, or almost as much as at the principal fellings. The facts and figures may be found at page 261 of my "*Traitement des Bois*" Since the beech after every thinning spreads out its branches at once, the soil remains practically always covered, the canopy fully complete, and the growth flourishing.

In broad-leaved high forest of mixed species it is another story. The ash takes for its motto "*excelsior*;" if it cannot get ahead of the rest it languishes and dies. The oak, also, is sore beset among the dense leaves of the beeches, maples, elms and hornbeam even; its finest branches are killed off, the most promising individuals are ruined. In certain high forests one may see the last of the oaks being strangled by the beeches, struggling by devious ways as thin poles, 25 metres long and a few inches thick, only to eventually die as slender starvelings. Such mixed forest calls aloud for thinnings, and they are not easy. To guard the crowns of the coming oaks from their infancy, when threatened by the froward birches, through their youth to their mature age, when ambitious neighbours still seek their ruin, requires both judgment and execution.

It may happen that the suppressed stems, the lower story, even the under-wood acquires a great importance for keeping the freed crowns in a good state of growth. In the happy days when the forests of Bains en Vosge were in my charge, we used to make thinnings among the oak and beech poles

One fine winter's day, while visiting a thinning being made in the 'Quart en reserve' of Bains itself, I espied a woodman, on the edge of the 'coupe' towards the Railway, carefully cutting back the seedlings of beech, which were thickly scattered over the scene of the thinning under the poles to be thinned. Perhaps he remembers to this day the compliment he got. Thinnings were only just coming into practice, and the poor man was only giving the coupe the usual "wash and brush up" as though it were a tan-bark coppice, where the operation is known as "ébrousser," "debroussailler."

It is easy to foresee the difficulty of thinnings in forests where the species are mixed in every possible way, but the complexity adds to the interest. I shall always remember my first walk in the Forêt de Haye with M. M. Parade and Nanquette, when I took charge of the Nancy-ouest Cantonment, which was about to be given over to the Forest School. Arriving from the Canton Anne Verjus, we proceeded along a compartment which comes to a point at the Cinq Tranchées. On our left, a very ill-constituted pole-crop dominated saplings of beech. In the absence of any officer, a brigadier had been thinning out the beech saplings below and cleaning the soil. "What a pretty sight!" said M. Parade, with a sly smile. "Yes," said I, rather warmly, "but the thinning is not made." "Well, make it!" was the reply. So, as soon as the leaves had fallen there was a cutting in the pole-crop. About 30 stères per hectare were taken out, aspens, beeches that were threatening oaks, coppice shoots overtaking beech saplings, and surplus stems of all kinds. Twelve years later M. Boppe thinned out the same 'coupe' and took out a lot more material, leaving from that time a nice young seedling forest of beech, oak and hornbeam over those 28 hectares that were formerly a tangled and disorderly mass of *supererogatory* stems. This juridical word was even used on another occasion a short time after by the first President of the Cour d'Appel to M. Parade, who was explaining the operation. The Magistrate had grasped the idea as one understands the definition of the term *thinning*, which indicates the classes of stems affected. The practical difficulty of discerning *which those stems are*, remains a matter of art and of skill.

With conifers, the matter is no easier than it is with the broad-leaved species. Look at a young pine-wood, uniform and crowded, and commencing to sicken in consequence. Every one of the crowns is a long narrow cone, reaching upwards and stretching for its life. Which are to come out? How many stems? Will the thinning be repeated and when? Can it be foretold? It is so difficult to differentiate, that one is tempted to fall back on a mechanical formula "*cut two out of three*;" or, perhaps, "*clear lines one yard broad, leaving two yards of forest between*." Nevertheless, it is possible for a clear-sighted forester,

aided by a careful guard, to do much better by lessening the crowding of the best stems without isolating them.

The pine-wood of Cervières near Briançon, in a level valley bottom, is stocked with mountain pine growing fairly fast. There I began my career. The forest was then a dense pole-crop, the thin stems no more than about 12 c. m. in diameter at breast-height, with a short and narrow pyramid of twigs by way of crown at 12 or 15 metres from the ground. They were sick and seemed that all they could do was to stand upright. I marked a bold thinning, and got a first-class stiff neck over it. I have not seen it since, but two years ago M. Algan, the *garde général* there, sent me a fine photograph showing the trees and men working among them for comparison, together with a description of the crop showing that stems of 40 c. m. are not scarce. These stems have, therefore, put on 30 c. m. of diameter in 40 years, to their original size. And still I have heard of another such dense and dark pole-crop at Gandissart, which at 60 years of age, on a cold slope, is still in that stage. The Briançon people say "they have always been so." But certainly they have not, for they only began life 60 years ago and must have been growing since, though at an imperceptible rate. They have never been thinned.

The larches which shoot up more rapidly, protect themselves better from a crowded condition; for the dominant stems go ahead and get the mastery; all the same uniform-aged crops from a single sowing often suffer considerably. This is seen. In the ordinary fellings for right-holders, or other fellings not fixed by area, it often happened that instead of following the paradoxical idea of some worthy unknown, and felling the finest trees, I would particularly select those that were troubling their betters, thus making a true thinning. The right-holders did not always like it, naturally, and one Mayor, the of Villars St. Pancrace, fell upon me with some heat. There was more waste heat some time later, when a big fire occurred in his village and it had to be rebuilt. Then the right-holders were uncommonly glad that the best trees had been preserved 20 years earlier.

In silver fir woods, though less indispensable, the thinning is still of great service. Besides permitting the disposal of surplus increment, it induces the sustained development of magnificent trees. The silver fir, though resisting indefinitely the pressure of its neighbours, often finds itself too crowded, as it advances in age, and it is a good deal better off for a little thinning out of trees of the same height; but the work must be gradual, for sudden changes of condition are dangerous. This species loves tranquility; it amplifies its foliage but slowly and never much; it likes coolness and freshness, and suffers from the introduction of sun and wind. Thus, if isolated after being brought up in a canopy,

it dies. We cannot alter nature. The silver fir loves a close canopy, let us take good care never to open it out. I, myself, coming from woods of pine and larch, was at first too bold among the silver firs, too much inclined to give them an excess of *air* as is commonly and wrongly said, instead of *light and space*. There was a compartment "M" of the forest of Grand' Cote, on a poorish soil with scattered boulders. Here I made a rather severe thinning. The felled stems fetched one penny each. Fortunately the poles were quite young, and we preserved the underwood. Feeble benefit on all sides, and a dangerously excessive thinning! After this experience I became more cautious in dealing with silver firs.

Among the spruces it is again different. This species is somewhat cosmopolitan; it can flourish equally well as an isolated tree on a pasture, or in close canopy. Yes, provided it has been brought up to it. In close canopy its roots are as scanty as its wig; if it is isolated late in life, the roots are wrenched about and the tree dries up. Our friends, the Swiss foresters, led on by enthusiasm, are perhaps trying how far they can go. The idea of thinning, *par le haut*, could not originate in spruce forests, and if I have contributed towards spreading it so far, I should, nevertheless, be sorry to see it carried to extremes. The thinning among the tops is indeed useful to spruce, but this species is certainly the one that has least need of it, and can do very well without it. For instance, see the splendid forests of the Ebenwald (Revue of 15th August 1898, p. 520), 800 to 900 stems to the hectare at 130 years old. There are also instances in France of forests that have never known a thinning. The rate of vegetation per tree is exceedingly slow, but what splendid sawyers' wood! And what a growing stock peacefully slumbering on foot! up to as much as 1,200 m. c. per hectare, at 120 years old. At 20 francs the m. c., the stock is worth 24,000 francs per hectare, which corresponds to a mean annual revenue of 200 francs per hectare. Is that not sufficient? May we not reply, like the young girl did to her Priest, "since those who marry do well, I will resign myself to it; let those do better who can." She omitted to state that she was in a violent hurry to get married. We are in the same situation with regard to the spruces. Who cares to watch a forest quietly growing for 150 or 200 years, without interfering, beyond the removal of the dead or dying trees? It is a good thing, nevertheless, in a few unfrequented parts of the mountains to spread the increment over thousands of stems, producing timber of the finest quality, even fit for sound-boards with rings only one millimetre thick. One is exceedingly glad to have such marvellous produce of long years and nature to sell, but who will consent to let his own woods grow at the rate of 20 centimetres per century?

Given a pole-crop of fine up-reaching spruces, the question is, what ought to be taken out in order to obtain a little produce and at the same time to improve the growth of the better stems? The answer is less evident, and the need for prudence is greater here than in almost any other forest. An even-aged pole-crop of pure spruce about 40 or 50 years old, may contain 2,000 to 3,000 stems per hectare. Many of these, being completely suppressed, are no longer an annoyance to their neighbours, but on the contrary are a decided gain, inasmuch as they improve the consistence and solid appearance of the crop. There is no good reason for their removal till their leading shoots have dried up, or some fault shows itself. The real struggle in the upper story thus lies among some 1,200 to 1,500 crowns. This is too many for us, it would mean less than half a centimetre annually on the diameter. We can gradually reduce the number by gently freeing the best and most vigorous crowns, but the crop is one united whole, inter-dependent and inter-responsible. Any sudden openings may tear or loosen the roots of one or two, and in consequence endanger the whole lot. This must be avoided. By working gently and frequently, say, every six years, only removing each time one crown out of, say, six in the upper story, twenty-four years will see the number reduced to half. Under average conditions of growth, this is going quite fast enough. As the crop gets older, the *proportion* to remove becomes less; after 80 years old it is small; and in a pure spruce crop, aged 100 years, there is very little to be done at all in view to its improvement, whether it has been previously thinned or not.

Which stems are to be cut in thinning the pole-crop? Those which are troubling the finest trees are naturally indicated. They are easily recognised, and must be removed gradually, one at a time, long before they are dominated. Thus, the crowns of the stems of the future get the best of the open air above, while their roots are freed from the struggle with those of the trees removed.

M. Guinier (in the *Revue des Eaux et Forêts* for 10th April, 1896) has indicated that in a pure spruce crop the trees to come out are those with narrow crowns. "*Etriquées*," from *strictæ*, seems to mean "narrow by reason of crowding." But, if all the narrow crowns are removed, there will be great risk of interrupting, impoverishing, and ruining a crop, however complete it may have been. Let us, therefore, say that the more aggressive among the narrow crowns are to be removed. Actually, in dealing with the operation of thinning, what one has most to guard against is excessive zeal. In trying to do too well, there is risk of doing very badly; one must know how to take sufficient time over the operation. This is the conclusion come to a few years ago, by a friend and myself, when discussing matters under the young wood

of Petite Fravelle, to the west of the *pré de la Messe*, where I had watched over its birth and its rapid growth in the early years. The surplus stems having become numerous, it would have been an interesting task to eliminate a few of those most hurtful to their neighbours, and it appears to me that a forester who once carries out a successful operation in such a case, ought not be diffident of his ability to do the same in any other conifer forest, and take an enjoyable pleasure over it.

Among the silver firs is it not far easier? Those that are suppressed, persist on and on for a very long time in the underwood; those that dominate, gradually enlarge their heads; the surplus crowns become deformed and condemn themselves. Add a few diseased, injured, or other hopeless stems, and the thinning goes by itself; any subordinate accustomed to conifers could do it. Then, the admixture of beech is a great assistance from its adaptability and general utility in aiding to complete the crop. Similarly, matters are simplified if there are silver firs among the spruces; each silver fir will become a mighty patriarch, surrounded by the spruces, which derive from it both support and fresh moisture in the soil. For further study of thinnings in silver fir, reference may be made to the "*Traitement des Bois*," where it is fully treated.

Most of our silver fir forests have been treated under the Selection method, and contain stems of all ages, mixed up together, which are consecutively reaching maturity. Then, they have to be removed, and sometimes their extraction is combined with a true thinning simultaneously. It would be safer to make the thinning two or three years later, when the absence of the large trees would allow a better insight into the requirements of the crop. But to return to our crops of uniform age.

Take scotch pine.—In this case the crowded state must be guarded against. The idea is here again easier to grasp than to execute. Still, when the pine tree is of natural origin, it is always more or less irregular, sometimes containing a few broad-leaved specimens, if only the transitory birches, which will shortly execute a natural thinning of themselves. The idea to grasp is that the pine lives in a canopy, open but evenly distributed, quite a different style of thing from isolated trees. This, once realised, the forester will free, without isolating, one or both sides of the crown. The operation is far more necessary here than in silver firs, and more remunerative.

The pure beech forest is the birthplace of the systematic thinning, which consequently presents no difficulty there. Free boldly at first and much more gradually later, or if preferred operate often in youth and at longer and longer intervals later. Either rule will give good results. Each time a number of thin or aggressive crowns, greater or smaller in proportion to the bold-

ness and date of the previous operations and to the rate of growth, will be cut out. The definitions of the term *thinning*, based on the *number of stems to remove*, arose in these high forests of pure beech, and are not safe to apply elsewhere.

As these crops grow older, an undergrowth of beech springs up, which remains starved and never coming to anything under the cover. Though probably useful, it is of little importance whether this exists or not. If it comes, leave it; if not, do not seek it.

Under the beech high forest of Dayancourt, aged 180 years, at Villers Cotterets, amidst a scanty underwood, notwithstanding the elevation of the very lofty crowns, M. Bagneris, who carried a long iron-shod stick, drove it in up to the top, so light and loose was the soil. How the oak would have equally prospered under such conditions! In similar soil in the Canton des Epinais, there is an oak called by the young folk the *chêne à l'unité*. It is 1 metre in diameter with a timber length of 20 metres, and therefore contains 10 m. c. of 1st class timber, worth 1,000 francs.

A high forest of pure oak (*robur*) must be properly thinned if it is to come up to expectations. The strangled crowns become very marked. By removing these and a few others that are simply over-crowded or supererogatory, the growth of the better trees is wonderfully improved. These will acquire diameters equal to one-fifteenth or one-twentieth of the timber length, instead of being limited to one-thirtieth, one-fortieth or even one-fiftieth. This is all profit, both in the present produce of the thinnings and in the future higher value of the timber per foot. One hundred oaks of 80 c. m. diameter and 15 m. long would give 500 m. c. timber and be worth an immense sum. Is not this the proper object in view in these high forests?

In course of time an undergrowth usually springs up which is encouraged by the thinnings. Whatever it may be, it will help to keep the soil light, in good condition, porous, moist and substantial; while it will be all the better should the undergrowth differ in composition, containing instead of oaks, for instance, holly, hazel, hornbeam, beech, &c. But these latter will rise up under the light cover of the oaks until they interfere with the good growth of these latter. Even under cover they seem to have the advantage and to struggle successfully. I have noticed this in several forests, notably at Fontainebleau south of the Croix Saint Hérem. It is therefore advisable, when the thinning comes due, to cut back at the same time all such strong-growing species like beech, and especially hornbeam. Possibly, their roots may damage the oaks as much in the soil as their crowns do in the air. I suggest this point for further enquiry.

This brings us to the study of the mixed high forest of oak and beech. The difficulty of bringing up, or even main-

taining the oak in this mixture is only too real, but forewarned is forearmed, for we have the means of overcoming it. I have in this place already indicated, in my study of natural regeneration, the way to obtain oak seedlings among the beeches. That question needs no further mention. The regeneration fellings will be hardly finished before there is a mass of saplings in which it is not very difficult to throw back the beech, but it must not be cut back to the ground, but only to the height of 5 or 6 feet. Thin weeding must be thoroughly done, not only round each oak, but over the whole area. The beech will start afresh quite sufficiently. Ten years ago, M. Viney did this in coupe No. 5 or 6 of the forest of Citeaux, on the left as you enter by the road leading from Chocelle to St. Nicolas. The result to be aimed at is the preservation of oak everywhere, with beech below it, even from the sapling stage.

The little oak poles soon begin to appear as such, the beech springs up between, and it is soon time for the first thinning which will remove principally beeches round the oaks. This time they are cut down to the ground and the oaks will spread and complete the canopy. The beech will undoubtedly remain in the coupe. The succeeding thinnings will boldly attack the biggest beeches, *because they are the most dangerous, and in this way the oaks will be kept flourishing.* Further, any beeches actually *below the oaks*, but reaching up into their chief boughs, can be cut back. In a coppice with standards the oaks are readily preserved and fostered in the struggle with beech, but this is done only by isolating them about every 25 years. In high forest we can do better by means of repeated and fearless thinnings.

The pedunculate oak, mixed with beech in certain forests such as Mormal (Nord), is generally found in moist places associated with most of the local broad-leaved species, *softwoods*, ash, elm, hornbeam, &c. It may attain colossal dimensions, but too often it is only found scattered here and there. It is, therefore, necessary to secure its regeneration if not abundantly, at any rate, generally. To this end, successive regeneration fellings are made, and at the same time the seedlings of shade-giving species among the oaks are cut back. It is a certain way of building up a forest. The following note, taken from M. Clement de Grandprey, a former Inspector-General of Forests, relates facts which illustrate this admirably.

"The forests on the immediate banks of the Rhine grow on stony, sandy, or fertile mud alluviums. In the first case, Scotch pine springs up naturally. In the second, a forest of every possible species. The pedunculate oak does exceedingly well, and even in some cases forms a splendid crop all to itself, notably in the State forest of Drusenheim, the Communal forest of the same name, and over 80 hectares of the Canton Steinwald in the Commune of Gamsheim.

Below the oaks is an impenetrable thicket of all sorts of species. How could such a crop arise? For the old crops who shall answer? But I know very well how the young ones were created. Some of these are faultless, and I have never seen better, unless perhaps on the banks of the Adour. When Alsace was still French, all the forests within 5 kilometres of the Rhine were subject to the supply of brushwood for fascines, &c., for embankment works. Consequently, the Forest Administration claimed little concern with them and they were made over to the Ponts et Chaussées. The engineers located the coupes, which were cut by contractors, without the remotest respect for anything. But fortunately there were a few old forest guards who got work there. These men could not bear to see all their instincts and traditions so ill done by, and of their own responsibility they persuaded the workmen to leave the oaks and elms which were found in the thicket. As the fascine-cutting came round every five years, the proceeding was tantamount to an excellent cultural operation and produced the crops that I so much admired."

The hint was enough for M. de Grandprey. Being appointed to Haguenau, he got hold of the fascine-forests there, submitted them to a rotation of 5—8 years, and thus continued the good work begun by those grand old guards. Where oak seedlings were wanting, he sowed broadcast, and success was assured.

Returning to our forest of beech and pedunculate oak. The development of the sapling of the latter amongst the suckers and coppice shoots of all sorts has to be followed with care. Thinnings are indispensable among the fast-growing wood. It is now a case of isolating the species with a light cover such as birch, ash, aspen, bird-cherry, even alder; with their high shelter, they will protect the young oaks from the spring frosts, while the species like elm and lime, that would suppress the oaks, have to be cut down. Thus, frequent repetitions of light thinnings will bring up the young oaks as they should go. Thereafter, thinnings at 10 or 12 years' interval will be necessary to liberally free the crown. But in soils where the auxiliary species attain a height of 25 and 30 metres, the mere freeing of the crowns will not suffice to give to the oaks all the space they exact. This fine tree loves to develop in girth and this can only be effected by assuring it ample liberty on all sides. As soon as the oaks have 12—15 metres of bole, the best attention should be given towards isolating the crowns of the choicest trees and maintaining them in this state by successive thinnings. The neighbouring crowns, kept at a limited distance, will continue to shade the bole, and as the oak grows and enlarges its crown, these trees will gradually disappear.

The various species naturally mixed will be far from possessing the longevity of the oak, and may reproduce again below the oaks an uneven and most useful underwood. Thus managed, a pedunculate oak forest, often interlarded here and there with

ash and elm, will do wonders. Such crops are exceptional in France, for lands that are irrigable or siltable are mostly occupied by agriculture or meadows. Even in the low-lying forests, it is frequently only in a few compartments, and especially along water channels within flood limits, that the genuine forest of pedunculate oak, alder and ash or elm, the true meadow-land forest exists. Generally, it is worked as a short rotation coppice with standards; this is easy, but in these coppices the oaks are often but thinly scattered and leave much to be desired on the score of shape and soundness; really valuable trees are scarce. The treatment of the pedunculate oak in high forest by the bold thinnings that are requisite for its luxuriant growth, gives produce of incomparable quality. Look at the oaks, growing among alders, cut every 15 or 20 years; imagine 50 of them to the hectare; fancy them double their present height; calculate their value at 120 or 150 years, when they will girth 3 or 4 metres, and see what it comes to!

The pedunculate oak is found also as high forest, even pure, on poor sand, but what a contrast! In 1869, under the pleasant guidance of M. Le Tellier, it happened that M. Bagneris and self visited the forest of Boulogne, which is contiguous with the park of Chambord, in Sologne. There, in the Canton des Theillet, we saw a high pole-crop of pure pedunculate, aged 100 years, very full but slender, ill-shaped, and only 20 cm. in diameter. It reminded me of the "Sleeping Beauty." At Compiègne, too, Canton des Vineux, there is a sorry high forest of pure pedunculate oak, originally planted, whose boles, already garnished with epicorms, make them appear to fear a thinning. The feeble crowns, the soil covered with heath, give no hope of a spontaneous restoration to better things. Had there been a mixture of beech, or an undergrowth of hazel, one could have thinned out the oaks and made something of them, though they are always ill placed on dry sands. Isolating them now would kill them; all that can be done now is to give them the thinnings and treatment appropriate to *Q. robur*, under similar conditions.

The above seems to me the procedure suitable in thinning our two oaks under various conditions. We shall thus realise the desirable ends set forth 75 years ago (*Revue* of 1st December 1898) by MM. Mallot and Le Grix, naval constructors. In many cases it is done already, and though our ships are now built of iron our oaks are not less in demand, for the price is greater than ever notwithstanding the general fall in prices.

The reader who has survived up to this point can now understand my views of the way thinnings should be made, *my style* in short, which I am far from alleging to be *ne plus ultra*; there are too many things we do not know. In any case, he will have seen that a thinning is not a simple operation, and that it varies exceedingly, between the spruce

growing pure, which can dispense with it, and the meadow-land pedunculate oak, whose crown by spreading freely gives to the annual rings ample thickness, strength, and quality. From one point to the next, at each individual tree, so to say, the thinning introduces different conditions. Satisfactory work can only be done by never losing sight of the guiding idea, and by having a close acquaintance with the life and behaviour of each species, pure and mixed, in every possible way. Such skill is only acquired by those who live in, and with the forest. It is infinitely easier, safer, and in every way more satisfactory to show the operation *in situ* in the forest than to explain it on paper. What the eye sees the mind may understand, but mere reading leaves but vague ideas, for no complete idea can be given of the extent of thinning. On the ground, it is the application of the main idea to individual cases that enlightens. It is the same with pruning fruit-trees, in fact with all questions of art. See it done, then read as much as you like, such is the only safe road to skill. It is, therefore, not without some apprehension of danger that this article is published.

Thinning is not only a delicate operation. However you attack a growing crop it is dangerous. The blighting of the whole crop and the degradation of the select stems has to be guarded against in different measures according to the soil and species, and these vary infinitely: particularly in mixed forests. Therefore, I have previously stated (*Revue* of 10th June 1896) that there is no definite formula for a thinning, there is no process or equation by which one can determine the number of stems to remove, or lay down which they are. This has to be done through knowledge of the various species, their temperament, exigencies, faculties, mutual relations, &c. But I think this is enough. I have known men who did not know *x* from *y*, forest guards even, who, having grasped the idea, could act on it and do very respectable work indeed in their own forest, their own beats. One of the most remarkable of these was brave old Antoine Gautherot, of Saint Broing near Gray. He was a woodman who became a guard in a private forest. He had never left the woods of la Vaivre, which surround the ancient Abbey of Corneux. In winter he could not tell *Salix alba* from *Salix fragilis*, but how well he knew the oak and the ash, the red elm with its two homonyms *white* and *diffuse* (though he knew not the name of the latter), and the alder, the aspen, the hazel, and the rest. He lived among them, his life was of theirs, he felt their difficulties, and did exactly what was needed. That is no trifle, I assure you.

The operation of thinning thus may be, nay always is, dangerous; the greatest danger is that of interrupting the canopy, and it must be carefully avoided notwithstanding the temptation to make a nice open crop. After what I have said about pushing the thinning of *Q. pedunculata* to the state

of isolation, I hope to escape being called an advocate of complete canopies at all costs, but how necessary the complete canopy is ! What good are isolated conifers ? Good to be cleared off at once ! What future has a high forest of beech if opened so much that several years must pass before the canopy is re-formed ? It is the future of a crop well on in regeneration fellings. Even *Q. robur* itself may be made to suffer, in the soil and in the air, to the extent of imperilling the future of the crop. Complete canopy is the natural state of forests, let us improve upon it only in showing proper regard for it.

Another great danger in thinning lies in the removal of the finest trees, be they silver firs or oaks, larches or beeches, pines or others, under some pretext or other. Crops so treated consist of a languishing residuum of unprofitable, feebly-growing stems, mostly of useless species, with a plentiful sprinkling of blanks which will not fill up. Concoctors of disastrous theories should be handed over to the hangman, and that without appeal, unless to the owners whose forests they have handled. If these latter are satisfied, so much the better ; but for our part let us keep our complete canopies filled with our best trees.

A third danger is that of a too heavy thinning, making openings in silver fir woods, gutting a high forest of oaks, destroying the due mixture of secondary species, or simply separating the stems too widely. The result is a shock to the constitution of the forests and a crisis in its existence. What our long-lived forest trees really require is a regular and sustained development ; the proof is easily seen by comparison of the two or three-hundred-year-old crops that still exist in a few forgotten, out-of-the-way forests.

From another point of view, heavy thinnings, but still made with prudence and frequently repeated, furnish a good deal of produce, which supplements and sustains the regular yield, sometimes makes it possible to await the due period of maturity, and becomes as important a factor in the revenue as it is in the treatment. It is known that a beech forest, according to soil, may give thinnings amounting to half as much, or even quite as much, as the principal produce. But the quantity can never be determined beforehand, since it depends on the ideas of the operator. In case of competition for the produce, a case of usufruct for instance, the question arises, " Who shall be judge between the parties ? Who shall see that the owner cuts enough ? Who shall see that the right-holders do not get too much ? Who can decide such a technical question, but a skilled, professional forester, called in specially and sworn to the task. The rules and limits by which he will be bound may vary within wide limits from one place to the next, here five or six stères may come out of 10 ares, there nothing at all. Thinnings are becoming more and more matters of daily

practice, and though they are at present ignored by the Civil Code the day is not distant when the owner of the bare land will be forced to surrender their produce to the usufruct beneficiary or the holder of the ground rent (emphyteutic tenure); it is the opening of a new state of things which the 20th century can only emphasise and confirm.

Lastly, the value of small material is falling to nothing, and that of all classes of firewood is similarly affected, whilst every kind of timber is more and more sought after. The deduction is self-evident. The future is for High Forests, complete high forests; standards over coppice with long rotation; plantations of conifers, all kinds of timber trees. The future is, therefore, also for thinnings.

Some owners wish to know how many stems per acre they can keep on foot at given ages in a regular crop. I have already said that there is no formula. It is easy to show the absurdity of expecting one. An oak pole-crop, aged 30 years, may comprise 4,000 to 5,000 stems per hectare, but only about 1,000 really forming the main crop. On cutting out the feeble and useless, there remain 1,000 stems suitably spaced. Ten years later, at the age of 40, half may be cut, say 500; at 50, cut a third of the remainder; at 60, one-fourth, and so on at equal intervals, one-fifth, one-sixth, one-seventh, one-eighth. Then, at the age of 100, there will remain $1,000 \times \frac{1}{8} = 125$ dominant oaks. Continuing as before there remain

at 120 years	$1,000 \times \frac{1}{10} = 100$ trees
150 "	$1,000 \times \frac{1}{15} = 77$ "
180 "	$1,000 \times \frac{1}{18} = 62$ "

Now, do the same for a spruce forest aged 30 years containing 4,000 stems, all included in the region of practical politics.

At 80 years old there will be	666
100 "	500
120 "	400
150 "	300

A silver fir wood aged 30 may contain 2,000 principal stems. Treated in the same way, it will, at different ages, contain one-half the number that the spruce has. What sort of result is this? Finally, whatever the species and the number "M" of stems contained at 30 years old in the complete crop, it may be thinned by the formula

$$M \times \frac{1}{2} \times \frac{2}{3} \times \frac{3}{4} \times \dots \times \frac{n-1}{n} = X$$

Under the definition by which this article begins, the number of stems to be preserved at different ages is, therefore, fixed by the formula

$$X = \frac{1}{n} M$$

The progression may be accelerated, or diminished according to the soil, by making intervals of 6 or 8, 12 or 14 years. The hyperbolic curve may be constructed, directrices and asymptotes marked out, and so on. What a treat for a mathematician, turned forester by mistake.

F. G.

How not to shoot a Panther.

It will probably be found to be the experience of every man who has done much shooting, that the disappointments he has sustained have been far more numerous than *the successes*. Men are, however, not generally eager to rush into print with accounts of their failures, which is the reason why nearly all the shikar stories that we read in papers and magazines, record the eventual satisfactory bagging of the game, either after good luck or successful skill and strategy. And yet it often occurs that there has happened more of interest on the occasions when one failed, than when one succeeded. It is for this reason that I propose now to give an account of a week's bad luck

and ill success, which was, nevertheless, full of incident though conducive at the time to excessive exasperation. To begin with, I must say that we were two guns; P. a recruit from Cooper's Hill, lately arrived and attached to me to learn his work, and myself. P is a good small game shot, but of course, had had no experience with big game. He was armed with a Paradox gun, with which he had made good shooting at marks, but the shooting capabilities of which he has yet to thoroughly understand. He was keen to shoot a panther and I naturally wished to give him the chance. We were camped at Galaor, a country of hills, any one of which might hold a panther. In days gone by, tigers were also to be had there, but there are none heard of now. Our *modus operandi* was to post Bhils in commanding positions along the hills, who, as soon as it got light in the morning, would keep a vigilant look out for panthers coming home from their night rambles. A panther having thus been more or less accurately located, word would be sent to us and we would go out and beat. The first day after our arrival in camp word was brought of a female panther with two small cubs being in a hole on a steep hillside. *Machans* had been made in trees just below and a live goat was tied up, and we then "sat up" in the afternoon in the hopes that the bleating of the goat would induce the beast to show herself. After two hours of ineffectual watching, men came up and told us they had just marked another panther down in a wide ravine on the other side of the hill. We went off at once to beat for it, and having posted P on a tree in a likely spot for the beast to come out, I went myself to the top of the steep hill slope on one side, where the beast was likely to break out, if he did not go straight down the ravine. Soon after the beat began the beast was seen moving a long way below me, and a few minutes afterwards I heard a couple of sharp reports from P's direction. Hurrying back a few paces, I saw the panther galloping off, about 300 yards from me, at the foot of the hill, and traced him into some high grass, where he disappeared. I then went down to join P and found that the beast had broken to his right, about 60 yards off, and that he had missed it with both barrels, though he had quite thought to have hit it, but found himself hampered by being on the tree. A consultation was held, but it was found that the beast had gone clean away and nothing more could be done. We went back to the same place next day and were presently told that a panther had again been seen to go into the same ravine that morning, and that, in fact, there were a male and female pairing and they had been seen together that morning. We had the same beat as on the day before, only this time I kept lower down the hill face, so that we both commanded the outlet of the ravine. I am doubtful if there really was a panther in the ravine. The men said there was and

that the animal broke back and went out at the "neck" of the ravine soon after the beat began. Of that I had my doubts, but what did happen was, that soon after the beat began, a tremendous hullabaloo from the watchers on another hill slope *behind* me, made me turn round on my tree, in time to see a panther charging down the hill a quarter of a mile away. It was then that our beaters came through with the tale of their beast having given them the slip. The new panther had evidently stayed in the *nallah* at the foot of the hill, since he had not been seen to climb any other hill slope, all of which were sufficiently open for an animal to be easily seen. We hurriedly took up new positions at the head of the *nallah* for a new beat. P was on a *babul* tree on one side of the *nallah* and I on a *bèr* tree (*zizyphus jujuba*) on the other side. There was a high dense bush on my left; but this did not concern me, as I expected the beast, if he came at all, to come up the sandy *nallah* bed, which I accordingly faced. I knew the beat would be a short one and accordingly I was on the *qui vive* the moment the shouting began. The first shouts had hardly died away when I heard the faintest rustling in the grass behind me. There being no wind at the moment, the noise made me suspicious and I turned by head quickly, just in time to see a fine panther bounding along, fifteen feet from the foot of my tree. I brought my rifle round sharply, but before I could get it to my shoulder the beast was out of sight behind a bush, and not a trace of him did I see again. He had evidently been lying up in the long grass not far from my tree, and had come along the path behind the bush on my left so stealthily, that I could not see him or hear him till the longer grass rustled against his side. This was ill luck with a vengeance. The beast had absolutely given himself away to me, but I had seen him a few seconds too late. Hastily getting the men together, we climbed up the hill to cut him off, in case he had stayed on the way, and the beat came through to us, but the panther had gone on and we saw him no more.

As the panther with the cubs might still be lying around, in spite of the noise we had made in beating, my wife said she would like to sit up for a couple of hours that evening as there was a good moon. Accordingly, we had the ponies saddled and went out to the place about 6 p. m. and sat up in the *machan* till 8-30 p. m., with a goat below us, who lamented his woes in a satisfactory manner for some time. No panther appeared, however, though after the goat had got quiet, a fine boar came and stayed some time eating roots and *babul* pods.

We had not yet finished with our ill luck, however. The next day was Sunday, generally a lucky day for shikar with me. *Khubber* was brought to us in the afternoon of a panther having been traced into the hill-side on the top of which is the

fine old fort of Galna. We went out at once ; P was posted a little way up the hill and I below the scarp and the beat began. No panther came out, but numbers of peafowls came all round our trees giving most tempting shots, and all the more tantalizingly so, that my wife had been urging us to shoot a peafowl to afford a change in the ordinary camp fare. I had made up my mind that, if towards the end of the next beat no panther had come out, and peafowl did, I would shoot one, and I got ready my shot gun accordingly. We then went off to get further round the hill for the next beat. This took us some time and we were so doubtful about there being a panther on the hill at all that I am afraid we went rather leisurely. However that might be, I ought to have remembered that, when Bhils are conducting a beat, they are very prone to begin too quickly. When we got to the places the men wanted us to stay at, there was some difficulty in finding a suitable tree for P. Having seen him finally settled and got hold of my spare cartridges, the man carrying which had lagged behind, I went higher up the hill to the second place and got on to my tree. This was a low and very awkward one, and I was arranging how I could settle myself to the best advantage, so that I could seize either shot gun or rifle, as might be required, when I suddenly heard the shouts of the beaters and at the same time saw the face of the man who was with me, freeze with a look of dismay. I looked hastily in the direction of his gaze, and there was the panther, galloping straight along the path which passed under my tree. As it happened it was the shot gun which I had in my hand at the moment ; and the more I waved my hand for the man to pass me the rifle in exchange, the less ability he appeared to have to move a muscle. At last I shouted to him and managed to get the rifle, the panther having by this time already passed my tree. Hastily cocking one hammer I brought the gun to my shoulder, only to find a branch in my way. I sighted afresh on the panther, just as he was disappearing, and pulled the trigger, but too late. The bullet hit the ground where he had been, and the panther was off. To say I shook my fist in the face of the native who refused me my rifle, is to relate only one tithe of the way in which my indignation and rage at him, and my self too, showed itself. The whole occurrence was too humiliating altogether, and one's *amour propre* could not stand two such shocks as this and that of the preceding day, however much one might, on cool reasoning, persuade oneself that really one was not much to blame in the matter, and that the two occurrences were sheer ill luck. I went down to P and found that he had seen the panther, which had passed in front of him at a gallop, ten yards off, but, seeing that it must go under my tree, he had naturally not fired. The beat had evidently begun much too soon and the panther had been started at once. Subsequent reflection made me think that

matters might have been considerably worse, as, if the beast had come along the path before my gun bearer and I were on the tree, it might have taken an unpleasantly good shot to keep him off one or other of us.

But the matter had not ended yet. We found out that a man on the fort walls on the top of the hill had been able to keep the panther in sight, and so could tell us that he had not yet left the hill. We, therefore, hurried round the hill to where a small ridge connected it with another smaller hill. A small, broken-down stone wall extended across the passage, part of the old fortifications, and to guard this I left P posted on a tree, whilst I went up the hill-side myself, thinking the panther might come along under the scarp below the fort wall, as was quite probable. The beat began again, and soon a yell from the top of the hill announced that the panther was on the move. Presently he came to the *nallah* dividing the two hills, evidently with the intention of crossing over and getting away round the smaller hill. Men immediately ran to head him off, and by dint of much shouting succeeded in doing this; and he went back into the *nallah* and lay up in a dense thicket of *Euphorbia* and shrubs. Here the beast sulked and was evidently most loth to come any nearer. The *nallah* led directly up to where P was posted, and I saw that, if the panther could only be moved, it was bound to come to him. I therefore moved a little down the hill and stood on an overhanging scarp, about 50 yards above P, so that I might, if necessary, get in a shot after him. It was rapidly getting dusk, and it was evident that, if we did not soon get the panther to move, we should have to leave him. The shouting, therefore, redoubled, and presently we heard yells that he had broken cover. Then I saw him heading up the path-way at a gallop, right in front of P's tree. A shot from him knocked the panther over, and I lost sight of him; but he was up again in a moment, gave three growls and then bounded over the wall, and was hidden again in brush wood before I could sight on him. I went down to P and found he had been unable to fire his second barrel owing to his position on the tree, but there was no mistake about the first having hit, though no blood could be found. It was too dark now for any thing more to be done, and so we returned to camp. On Monday morning we started off to try and track the beast and soon came across a spot where he had evidently lain up, and where blood had soaked into the ground. We followed his pugs for a short distance more and then lost all trace, and we had to give up the pursuit. Subsequently however, pugs were found on a path leading out of the hill forest and it became clear that the animal could not have been hard hit, and that he had gone clean away in the night.

We stayed a few days more at the camp, but had no more *khubber* either of this panther or of any other, and thus realized the truth of the old adage that:

“ He who will not when he may,
When he will, they'll say him nay.”

G. P. M.

Forestry in the United States.

The report of the Executive Committee of the American Forestry Association, read at the seventeenth annual meeting, and recorded in their magazine, 'The Forester,' contains the following interesting account of marked progress.

The most important work of your Committee during the past year has been its contribution to the successful endeavor to ward off the threatened attack upon the forest reserves set apart by President Cleveland, which had been suspended for one year prior to March 1, 1898. In the last Sundry Civil Bill the Senate inserted a proviso suspending the President's order setting apart these reserves, and restoring them to the public domain. Your Committee, on April 2, decided to take action and sent out circular letters to all members of the Association urging immediate protest. On April 13, a memorial was sent to all members of Congress, urging that the Senate amendment, if adopted, be limited to one year. Still later, specific amendments to the Sundry Civil Bill were suggested to the committees of the House and Senate. The efforts of this Association were in line with, and were assisted by those of officials and private individuals, and the combined protest had its effect. The House refused to agree to the Senate amendment, and the reservations were saved.

During the past year, there were submitted to the Association some eighty-nine designs for a corporate seal. A competent jury of well-known artists and architects passed upon these designs, and decided that no one of them was possessed of sufficient merit to warrant your Committee in paying the prize of \$100 offered to the successful competitor. The designs were exhibited at the Cosmos Club in this city, and surprise was expressed that they should have been so unsatisfactory.

In June last the Association met with a loss in the resignation of Dr. B. E. Fernow as Chairman of the Executive Committee and Editor-in-Chief of THE FORESTER. His peculiar fitness for the position, his ability, his jealousy of the rights of this Association, and his untiring and aggressive enthusiasm for the work, have been of very

great value to the Association, and have contributed in no small degree to the progress it has made and the influence it has wielded. The retirement of Dr. Fernow, to take charge of the New York State College of Forestry at Cornell, is regretted by none more than those who have been so long associated with him in the work of the Executive Committee.

The progress of forestry in the United States, during the year which is about to end, has been most satisfactory. Public sentiment throughout the West, which, soon after the proclamation of the Cleveland Forest Reserves, was in an attitude of bitter opposition, has continued the remarkable change begun during the year which followed the proclamations, and at present opposition has practically died out. The only conspicuous exception is in the State of Washington, where the Republican platform contained a clause asking for a restoration to the public domain of all those portions of the forest reserves valuable for agriculture, mining or timber. In the Black Hills, where the protest was perhaps more vigorous than elsewhere, it has been replaced by the most cordial feeling, so that the Black Hills Forest Reserve has been increased by nearly half a million acres with the full assent and co-operation both of the local population and of their representatives in Congress.

Four new forest reserves have been created since the eleven suspended reserves emerged from that condition on the first of last March. These are the *Pine Mountain and Zaca Lake Reserve* in Southern California, of 1,644,594 acres, the *Prescott Forest Reserve* of 10,240 acres, the *Black Mesa Reserve* of 1,658,880 acres, and the *San Francisco Mountains Forest Reserve*, of 975,860 acres, all in Arizona. In addition, the boundaries of the *Pecos River Reserves* in New Mexico, have been changed and enlarged to embrace 120,000 acres more, and those of the *Black Hills Reserve* have been similarly changed, with an estimated increase of 433,440 acres, a decrease of 189,440 and a final total of 1,211,680 acres.

The care and protection of the forest reserves has been entrusted to the General Land Office. For that purpose an appropriation of \$175,000 was made by the last session of Congress, and during the summer the work of organizing a forest force has been begun.

The report of Mr. Frederick V. Coville, Botanist of the Department of Agriculture, on Forest Growth and Sheep Grazing in the Cascade Mountains of Oregon, brought the question of forest grazing to public attention in a thoroughly scientific and practical manner for the first time. No other single factor has contributed so much toward a settlement of this most important question. The approval of Mr. Coville's plan by the sheep men was instant and widespread.

The foundations of the New York State College of Forestry, with Dr. Fernow as Professor of Forestry and Dean of the Faculty, and Mr. Roth as his assistant, is the most notable step yet taken in forest education in the United States. The last available report gives the names of 39 students of Cornell University, who are participating in the courses of the school.

During the year another forest school, on simpler lines, was begun at Baltimore, in North Carolina, under the direction of Dr. C. A. Schenck. Four students are in attendance on the thoroughly practical

courses of the school. The mapping and description of the forest reserves, under the direction of Mr. Henry Gannett, of the U. S. Geological Survey, has proceeded very satisfactorily during the past year. Nineteen reserves have so far been examined, and statistics of standing timber have been collected for Washington, Northern Idaho and part of Oregon. The Association is particularly to be congratulated on the prospect of possessing, in the near future and for the first time, *reliable statistical statements of forest resources* in some of the most interesting portions of the country.

The resignation of Dr. Fernow from the Division of Forestry was followed by the appointment of Gifford Pinchot as Forester of the Department of Agriculture, and by the reorganization of the work of the Division. The attention of the Division is to be directed hereafter to *field work as fully as the circumstances will permit*. A Plan of the Division, outlined in Circular No 21, by which it undertakes to assist private owners in the care of their forest lands, has been responded to by applications for such assistance, which cover about 1,100,000 acres.

The action of the International Paper Company, in appointing Mr. Edward M. Griffith, a trained forester, to assist in the management of its timber lands, is a notable step forward in the progress of forestry, since this company is by far the largest producer of wood pulp in the United States. Mr. Austin Cary has been appointed by another company for a similar purpose.

The purchase of forest land by New York State, in the Adirondacks, under the appropriation of \$1,000,000, had resulted, at the last report of the Forest Reserve Board, in the expenditure of more than \$900,000 and the acquisition of over 25,0000 acres at an average price of \$3.685 per acre. The school forest of the New York State College of Forestry, of about 30,000 acres in extent, has recently been added, only, however, as prospective State property, since it will belong to Cornell University for a term of years before reverting to the State. *Pennsylvania has acquired 55,681 acres of wild lands* as the result of an admirable plan for the creation of State forest parks at the head-waters of important streams, and the rebate provided by law in the taxes of timber lands is beginning to be widely claimed. Forestry Associations have been established in Utah and Massachusetts, and the latter has been exceedingly active in forwarding the good work.

One of the ends for which the Association has been striving for many years, namely, the establishment of a Government system of forest administration, having now been attained, the members of the Association can devote their energies to no more important object than the maintenance of a public interest, which shall insure efficiency in the administration of the forest reserves.



CUTCH-BOILING IN BURMA.

Photographs of catch-boilers' camp.

For the accompanying photographs the Editor is indebted to the courtesy and artistic skill of the wife of a well-known Forest Officer in Burma. The scenes depicted represent a camp of Burmese workmen engaged in the manufacture of catch from the wood of *Acacia catechu*. In the upper photograph a log of catch wood is in process of conversion into chips, which are boiled in earthen vessels shown in the lower picture. The solution, obtained by boiling in these pots, undergoes further boiling in the evaporating pan shown in the photograph, until, on cooling, it attains the consistency necessary for the ordinary purposes of the market. The process is too well-known to need detailed explanation* ; and though primitive and rude, it is sufficiently effective to produce catechu of very considerable value and to offer fair remuneration to the labourers engaged in the industry. Of late years, catch manufacture in Burma has greatly declined

* Full description of the method and statistics as to yield are recorded in the Dic. of Econ. Products.

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owing to various causes attributable partly to temporary depletion of the forests, in many localities, of cutch trees of workable size, and in part also to alleged replacement of cutch by other substances, in some of the industries in which catechu was formerly chiefly in demand. Recently, however, the trade in Burma has shown signs of revival, and to ensure permanency of supply of this useful product, measures have been taken for preservation and reproduction of *Acacia catechu* by reserving the most productive cutch forests and by establishing plantations on a considerable scale.

Some remarks on forest concessions in Oudh and in general.

The Forest reserves in Oudh occupy the Northern portion of three districts on an area of 923 square miles. Outside these tracts, the production of timber fit for building purposes is insignificant and is, moreover, constantly decreasing with the spread of cultivated area. A population wholly engaged in agricultural pursuits, and as dense as in the most crowded European States, must therefore obtain its requirements from the Government Forests situated either in its own, or a neighbouring Province, but it is probable that the influx of timber from the North-Western Provinces, Nipal or Bengal is not in such quantity as to warrant consideration. Happily the provincial demand, imperative as it may be, is not exorbitant. Outside the towns and cities the peasantry are content to dwell in thatched huts of wattle and daub, or in roughly tiled residences with mud walls. Permanence of abode indicates the power of purchasing durable building material, and, therefore, comparative wealth; the absence of that affluence, accentuated by the scarcity of cheap wood, compels the construction of houses whose inferior material has no duration, and is, therefore, necessarily renewed almost annually. The poor quality of timber used in the majority of villages at a distance from the forest, is apparent to the most inexperienced observer, and the inference is that the supply of timber at prices within reach of the peasantry is insufficient, and that, in consequence, the cultivating classes suffer in not possessing weather-proof houses, and in the expense attendant on the constant necessity for repairs. It will be allowed that, especially in a country where extremes of cold, heat and

The importance to the country of a cheap timber supply.

damp are marked features of the climate, the people cannot be at their best, much less improve in physique, without adequate protection against climatic influences; even the peasant acknowledges this fact in his practical way by the construction, so soon as he can afford it, of a permanent and more commodious residence.

(2). We may next consider the position of Government in reference to forest management, and though the following remarks may not be subscribed to by all, yet it is possible that the opinions expressed may be more or less general. The outturn of a State forest is the property of the State, to be utilized for the benefit of the country in such a manner as the Government may consider to be most desirable; provided that the community as a whole profit, the method of utilization is theoretically immaterial. Amongst other ways it may be accomplished directly by providing an adequate supply of building material at a reasonable price, or indirectly by reduced taxation. In practice both these results may follow, the sale of the

On the responsibility of Government and of the Forest Officer.

more valuable timber will bring in revenue to the Government Treasury; the protection of less important woods will place material suitable for village requirements in abundance on the market. Again, the amount of the outturn is dependent, theoretically, on the work of the Forester; he can estimate the normal yearly increment and propose such arrangements as will bring the area under his charge to its full yield; but, in practice, he may be restricted in his work by local encumbrances, and prevented from utilizing for the production of timber a part, or even the whole, of the forest area. The Government of the country is thus responsible, not only for the proper utilization of the forest area, but also for prescribing the utilization of the outturn therefrom; the Forester is responsible that, so far as he is permitted to do so, the forest in his charge shall be in the highest state of efficiency.

(3.) The forests of Oudh are free from all rights of user; in them Government possesses an unembarrassed estate, in trust, not only for the present population but also for future generations. But there are certain paramount claims, which have to be considered, before the utilization of the forest area and of its yield can be decided on in detail. These claims are those of the villages which surround the forest or of their owners. In former days, the Settlement of these village areas was difficult owing to various untoward circumstances; the inroad of wild beasts on flocks or crops; the unhealthiness of the locality; the absence of all that makes peasant life enjoyable, such as good water, attractive shops and gay society; the isolation of these tracts, indeed, at that time often resulted in a mono-

The origin of Concessions.

tonous life of sickly toil. Low rentals and free forest produce were the inducements offered to tenantry to settle in the vicinity of the forest, but as the country became opened up by improved communications and by increase of population, the landlord increased his rentals and Government its demand, whilst the State forests remained burdened with the *onus* of supplying, to the direct benefit of the landlord, free grants for an ever expanding population. It is the history of the attempts to satisfy and define these claims that it is proposed to narrate; the story of how the balance has wavered between the demands of those nearest the forest, and, therefore, most readily able to utilize its products, and the rest of the community whose need is doubtless as urgent and their claims perhaps even more so; for they are infinitely more numerous and probably also infinitely more valuable to the State as representing *par excellence* that source of revenue, on which the stability of Imperial finance mainly depends. No criticism on the action of Government is here attempted or intended. A bare statement of facts which have occurred during the last 20 years is presented, and from them the reader, be he Forest or Revenue officer, can judge of the progress made in deciding what portion of the State forests and their yield should be devoted to the benefit of the neighbouring villages, and what portion should be set aside in satisfaction of wider claims and more general interests.

(4) In 1879, or some 15 years after the establishment of a Forest Department, a committee, composed of a Revenue and a Forest Officer, was appointed to consider the question of privileges and concessions and to report thereon for the information of Government. The Revenue Officer visited the forests and submitted his report, able and painstaking, but marred by certain expressions of opinion raising questions, which had long passed the period of discussion, and were even then accepted as facts throughout the world of science. The Forest Officer submitted no report; he annotated a copy of his colleague's production and so lost both the opportunity of placing departmental views before Government and also of making proposals, which might have, once and for all, laid to rest the vexed question of concessions. In the circumstances it was inevitable that Government should accept the only proposals made, and the order issued that all villages within 3 miles of the forest should receive grazing at one-half the usual rates, free, unreserved timber for building and agricultural purposes, free grass for thatching and thorns for fencing; whilst the *Tharus*, a caste apart, in return for a specific service, viz: gratuitous aid in fire conservancy, were to receive free, dry *sal* wood for wells and bridges. Such, however, was the lack

The first attempt
at definition.

of perception in the local Forest Department that the importance of defining the amount of produce was not grasped: in two of the three districts, the so-called 3-mile villages were listed; in the third no such record was ever completed, while it remained for the Revenue Officer to represent to Government the advisability of fixing the quantity of produce to be granted; and, when the necessity of such a proceeding was questioned, the Forest Officer failed to show any insistence. For subsequent trouble and labour the Department must, in a great measure, hold itself to blame.

(5) The incidence of the concessions thus granted was not at first oppressive to the forest, at least so far as the grant of timber and produce was concerned. These privileges were guarded by a clause which made it penal to sell or barter produce given for a specific purpose, and this rule afforded a check, not entirely efficient, but at any rate helpful in restraining inordinate demands by the villagers.

There is no doubt, however, that the free grants of produce did filter through the 3-mile villages to others outside the radius, but, whether these illicit transactions were carried out entirely by sales from the privileged villages, or by connivance with the forest staff, is not apparent. It may safely be surmised that both, villagers and staff, combined to make easy a proceeding so much to the benefit of all three parties. The concession which became, however, intolerable in its undefined enormity was that of grazing at half rates, and this without any restriction as to the number of cattle or to the agricultural requirements of the owners. In a few years' time an agricultural tenantry was supplemented by a pastoral community, which settled itself in the privileged villages, thus reaping all the advantages intended to assist in the spread of cultivation. Gradually their cattle over-ran, not only the State forests, but also the fields of their neighbours, who had thus more difficulty in protecting their crops from domestic cattle, than from the few wild beasts who still found standing room in the forest. A system was even introduced in one forest of turning large numbers of cattle loose and of only rounding up the herds yearly to collect the calves for sale; and in consequence damage done to cultivation within reach of the forest became insupportable to the tenantry who, such is sometimes the irony of circumstances, either made no advance in number, or actually decreased owing to unregulated generosity in conceding privileges; whilst the Forest Officer was reduced to despair at the spoliation of the forests. It may hardly be believed that up to 1898 it was in practice an accepted fact that there could be no satisfactory grazing without firing, that, the experience gained in other countries besides India proving that protection from fire results in killing

down the ranker grasses and favoring those more suitable for fodder purposes, should have been unknown or ignored. (In this connection the history of the vast cattle breeding grounds in South America may be found both interesting and instructive). But this will not be considered so surprising when, in the penultimate year of the century, we find a Revenue Officer in a most responsible position as regards forestry, stating publicly that fire-protection is, in hill forests, actually pernicious to the forest. Forestry is evidently a science which is permitted no axioms and whose elementary propositions may be disputed by those, who have no theoretical knowledge, and mistake the superficial observations of a few days or months for practical experience.

(6). The position in the Oudh Forests, resulting in undefined concessions and erroneous ideas in regard to the effects of protection, was shortly that produce, vastly in excess of the domestic requirements of the 3-mile villages, was yearly withdrawn from the reserves; whilst the area which could be worked as tree-forest was enormously reduced in order to supply grazing grounds for cattle breeding. The details of this industry are worthy of note and the inferences drawn may be checked from the reports of the Veterinary Department on Cattle breeds in India. The

local breed of cattle had, in the past, obtained some
 On cattle breed- ing and forestry. notoriety on account of its size and courage; the individuals composing the herds were valuable; the village waste lands were extensive, and the grass lands in the neighbouring forests afforded ample grazing during the summer months. Without over-crowding and with the care which the agriculturalist is able to afford the few animals in his charge, a good breed of cattle was created and maintained. The case became different when the concessions attracted large herds of cattle, either to settle permanently in the vicinity of the forest, or to pay annual visits from a distance. These animals were left to shift for themselves, no attempt was made to regulate their breeding, they died in hundreds from disease, hunger or exposure, whilst the best of the survivors were sold in their youth and owed what strength and vigor they attained to the personal care of their purchasers and to stall-feeding. The ruin of the forest brought no benefit to agriculture but rather the reverse, for home-reared cattle will always be superior to those only semi-domesticated, and forests, though they may be a helpful adjunct at that period of the year, when field fodder is scarce and labor is so plentiful as to permit of careful herding, are not indispensable to maintain the supply of cattle; if this were the case, it would fare ill with those Provinces, which possess no forest grazing grounds, and yet prove their independence by producing a breed of cattle much superior to any in the Province of Oudh.

(7). Up to this time no Working Plans existed to bring the forests under regular treatment, but the value of the forests and the necessity, in view of the constantly improved communications, of regulating the yield rendered it absolutely necessary to remedy this defect. But even before the first steps were taken in this direction, the Forest Officer was met by the impossibility of fixing the details of working or of estimating the outturn so long as the area for the supply of concessionists remained undefined. When these facts were represented, the responsibilities in the utilization of the forest areas, and of their yield, were recognized, and permissions accorded to the compilation of records of concessions, which were once more expected to settle, for ever, the questions which had been under discussion for so long. The importance of the subject necessitated that it should be approached with the greatest care, and a Forest Officer of the Provincial Service was put on special duty to examine the circumstances of each 3-mile village, to enumerate the houses and cattle, and to estimate the requirements of the people on the basis of cultivated area; in short, to collect all statistics bearing on the subject which might assist Government in arriving at a decision. The thoroughness and accuracy of this work was acknowledged by Government, who was thus enabled to fix the foundations on which the detailed superstructure of the record of concessions should be reared. The basis of this record was that in such villages, within a distance of 3 miles from the forest, as were selected for the continuance of enjoyment of privileges, cattle should be admitted to graze at half rates up to a maximum of 4 head for each 10 bighas under cultivation, provided that the area available for grazing outside valuable tree forest allowed of one acre per head of cattle being set aside for this purpose. If the area available were less, the cattle were decreased; if more, then surplus cattle could be grazed at full rates. Each cultivator also was entitled to receive for each 10 bighas under cultivation 30 c-ft. of unreserved wood annually or one-third that amount of *sāl*, on payment of one-third the market rates. One and a-half cart loads of thatching grass were also allotted on the same terms, whilst thorns and fuel were given free up to actual requirements. The decision to make these concessions on payment emanated from Government; it was considered that by placing a money value on the produce, wasteful utilization would be abruptly checked, whilst the departmental regulation of the concessions would perforce receive closer attention. It was, moreover, made penal to sell or barter produce which had been received for a special purpose at special rates. On these lines records for all three districts were prepared, and of these, two received sanction and came into force; whilst the introduction of the third was postponed until a grazing lease,

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which for 20 years had burdened a portion of the reserves, had expired.

(8) The effects expected from these new rules may now be considered. In the first place the areas open to grazing were defined, and thus the Forest Officer knew where felling operations might proceed and where they were not permissible; secondly, the maximum demand in unreserved and *sal* timber, and in minor forest produce was known, and no further impediment, therefore, existed to the systematic working of the forests. Further, wasteful utilization was to be effectively checked by the imposition of a small royalty, whilst the prohibition of sales of forest produce granted for agricultural purposes tended to act as a further deterrent on indents for amounts in excess of actual requirements. The introduction of the new records caused some dismay amongst the tenantry, more amongst the cattle breeders, and perhaps most amongst the landlords, who emphatically opposed it. They probably anticipated not being able to ask such rents as in the past, for the reason that they could no longer guarantee to their tenants such full use of State reserves as in former years; they foresaw that they might be obliged to grant, from their own waste lands and forests, a supply of grazing and produce which they had hitherto obtained from outside; the cattle breeders, too, recognized that the grazing in the forests would in future be held primarily for those occupied in cultivation; whilst the tenants were annoyed at the restrictions imposed and were doubtful if the landlords would prove as generous with their wood-lands as they had been with those of the State. For the first year of working, misapprehension and the dullness of the Hindustani of the lower classes in grasping any novel regulation, effectively backed by the stocks of free timber in hand and the assistance temporarily afforded by the landlord in facilitating grazing in private lands, enabled the people to prove their independence of the State forests; but in the following year they commenced to enter into the new order of things, and demands for timber and grazing recommenced. What the ultimate result would have been; whether in a short time the tenantry would have valued and exercised their privileges, or, on the other hand, considering them worthless would, like many millions of other cultivators, have found it possible to do without them, it is impossible to say. These questions may be left to be answered by those qualified to do so, for this is a history and not a prophecy; but, while the statistical statement appended will enable a comprehensive view of the situation to be taken, the records of 1894-95 and 1895-96 did not survive long enough to enable a narrative of their working to be recorded.

(9) In 1898 Government, considering that the existing arrangements for utilizing the State forests in Oudh might not be entirely desirable, referred the question to the Revenue Officials and supplemented their reports by a visit to the forests in one district. In result the existing records were deemed to be unsatisfactory and the compilation of others on a new basis was ordered. The alterations

The third attempt at definition. in the system now considered necessary were based on the opinion that the villagers in the vicinity of the forest had not received sufficient consideration; that the utilization of the State reserves should be primarily for the benefit of those whose residences may be in the immediate neighbourhood; and on this basis the following orders were issued. That the tenantry in the villages on the privileged list should receive grazing at half rates for all the cattle they owned up to the maximum area available, without encroaching on valuable tree forest; that they should receive free, and without restriction as to sale or barter, 20 c-ft. of unreserved timber in poles, or 30 c-ft. in large timber, or one-third that amount of sâl for every 10 bighas under cultivation; and on the same terms two cart-loads of grass, and fuel and thorns free to an unlimited extent. A census of cattle and houses was to be taken and the details of the record was to be worked out thereon.

(10) The important changes in this recognition of the claims of villagers in the neighbourhood of the forest was thus two-fold: *First*—The number of privileged cattle were

The effect of the third definition. not restricted to the purely agricultural requirements of the people. The grant of the grazing privilege depended on chance, on the number of cattle which happened at the time of the census to stand within the limits of any individual village, without reference to the uses to which these cattle were put. Where, however, the grazing areas are insufficient to support the entire number of cattle present in the villages, the allotment of privileged cattle by villagers is to be made by the Revenue Officer, and in such cases the agriculturalists should, in theory, have the advantage over his neighbour engaged in trade. Whether he will do so in practice may sometimes depend on the Patwari. *Secondly*—The grant of produce, though based on the agricultural requirements of the people, was not limited to these requirements; the grant in the first record was unlimited; in the second it was 30 per cent in excess of the estimated actual requirements; but this generosity was intentional on the part of Government in order to minimize any possible hardship in the rule, that the produce considered necessary for a specific purpose, should only be utilized for that purpose. In the third record the utilization of the grant is undefined; it has a money value and is negotiable and, therefore, certain

to be availed of in full. In the second record, two-thirds of the grant might be taken as the maximum demand, probably much less; in the third, the whole grant must be taken as the probable demand. It is impossible to compare the incidence of the concessions under the second and third records; the latter have not yet been completed even in the one district for which Government orders issued in 1898. The collection of data is a slow process, and it is yet unknown what will be the maximum demand in produce; but, so far as it is possible to do so, the figures have been worked out in the appendix to these notes; but they are of no value unless it is remembered that the grant of 1898 is absolute, and that of 1894 conditional.

(11). It may be the opinion of some that, the settlement of forest concessions might be as readily completed as the settlement of the incidence of land revenue, and that a revision of the record once in 20 or 30 years would here also meet the necessities of the case; but the facts narrated in the preceding paragraphs tend to show that the settlement of privileges may take some 30 years to complete, and may require revision in as many months. In Oudh, at this moment, finality is as far distant as before 1879, and the experience of the past does not justify the hope of its speedy attainment. The necessity for the definition of concessions is admitted, but the terms on which these should be granted, the requirements on which the privileges should be based, the classification of necessities as opposed to luxuries, the claims of the few as compared to those of the many, all these details are still finally undecided. Forest officers were at one time gratified when the area in their charge was free from rights of user; they preferred to grant privileges rather than to record rights, but it seems probable that their congratulations were premature. Where rights exist, they are settled in a prescribed method, once and for all. The law regulates their enjoyment, there is but one discussion and that merely as a preliminary measure. Where concessions are granted, there can be no definite end unless the forest policy of successive Governments coincide. The general policy it is true is Imperial, but the interpretation thereof is personal, and varies within wide limits. Each Government may be, and doubtless is, right in this interpretation; but the differences which must occur are destructive to continuity in working the forest. The State forests are as islands in a sea which may all too readily engulf them; the strong but gentle swell in the offing represents the demand of the general population of the Province; the surf, dashing against the seawall, the restrained appetite of the rightholders; whilst the efforts of the concessionists may be likened to waves breaking on an unprotected shore; without unintermittent watchfulness the

result must be a gradual but certain victory to the invaders.

(12). The chief causes tending to relax this watchfulness originate possibly in failure to recognize the importance of forests in the economy of a State; they are too often allowed only to possess a strictly local value. But even when this view of the case is taken, deterioration of forests need not follow. The villages in the neighbourhood unquestionably benefit by receiving a very large proportion of the expenditure on the works that are carried out therein; let them receive, too, in money, the full value of their concessions and also be given the opportunity to purchase, at the market price, forest produce at their doors. In this, or in some similar way, they could have no personal interest in forest management nor claim any right to control it; but as long as that interest is admitted and that right allowed, in practice if not in theory, so long will agitation continue and so long will the grievances of the agitators, be they forest officers or tenantry, be liable to decision according to the actual wants of one or the other, instead of in accordance with the relative importance to the State of agriculture and sylviculture. If the interests of the forests are held to be antagonistic to those of cultivation, such relative importance no longer exists, but in a well-ordered State there is not only room but a necessity for both agriculture and forests; the settlement of the one is as necessary as that of the other, for, in either case, without security from sudden or frequent changes, there can be little welfare and no improvement.

Forests and cultivation not antagonistic.

(13). The reader who is interested in these matters can now sum up for himself; certain facts have been laid before him, certain theories have been suggested. The impartial critic will, it is hoped, not be able to complain that undue stress has been laid on demands for the welfare of the forest. The Forest Officer is in theory independent of the forest revenue, but in practice he views its diminution with distaste as restricting the outlay he is permitted on works of improvement and protection. Still, he knows better than to complain; he desires only that the management of forest areas should be on a secure basis, so that he may be able to arrange 30, 50 or 100 years in advance, for the harvest which will take that period to mature. He desires to eliminate, as far as possible, all elements which may induce a change in management during at least one cycle of growth; and if at the same time he is anxious to restrict, within reasonably liberal limits, the demands on the area under his charge, he is at least actuated by disinterested motives; for his sole reward will be in his knowledge that he has induced improvement in the forests under his charge, and in the recognition of his labors by those who know.

*Statement showing the Incidence of Concessions in one Division
in 1894 and in 1898.*

Serial Numbers.	Description.	Area in square miles.	C-ft.	Cart-loads.
1	Area of Division ... { Stocked 210 Unstocked 121 }	331		
2	Area in which grazing is permitted ... { Stocked 67 Unstocked 118 }	185		
3	Area set aside for use of Concessionists as grazing grounds. { In 1894, { Stocked 67 Unstocked 24 } In 1898, { Stocked 69 Unstocked 54 }	91		
4	Area available for other cattle in 1898 ...	64		
5	Area available for regular treatment in 1898 ... { Stocked 141 Unstocked 3 }	144		
6	Maximum allotment to Concessionists in unreserved timber in 1894, on payment, without liberty to sell ...	...	709,346	
7	Maximum allotment to Concessionists in unreserved timber in 1898, free and with liberty to sell *	...	709,346	
8	Maximum allotment in grass as above in 1894 ..	...	...	35,446
9	Do do do in 1898 ...	...	...	47,261
10	Incidence of grant of unreserved wood per acre per annum over area in (5) ...	...	7.9	
11	Incidence of S&I wood as above ...	...	2.6	
12	Outturn necessary per acre of unreserved wood on a 20-year felling rotation ...	...	158	
13	Outturn of S&I as above on a 30-year rotation ...	...	78	

* The grant of 1898 may be more than of 1894, but will not be less.

Tannin Extracts.

During the past few years considerable efforts have been made in the way of practical inquiries in the preparation of Tannin extracts from products of Indian forests, and in their examination and analysis. Forest Officers responded willingly.

to the appeals made to them by the Inspector-General to prepare and send in extracts of any materials which, from local experience or practice, it was thought would probably yield *extracts of commercial value*. Thus many more or less useful extracts were sent to the Reporter on Economic Products and to the Forest School at Dehra, from Burmah, Bengal, the Central Provinces and Coorg. The examination and analysis of these extracts made in Calcutta showed that, although they had all been prepared in much the same manner, viz., by the method employed by the cutch boilers in Burmah and elsewhere, they varied very greatly in the amount of tannin they contained. Some of the extracts were sent in a liquid condition, and these were found almost invariably to ferment and spoil in a very short time. *Others had been rendered useless* by the application of too much heat, and others were reduced in value by the admixture of a considerable quantity of gum and coloring matter, and some were quite useless on account of the amount of dirt and foreign matter which they contained. A number of the better extracts were analysed by Mr. D. Hooper, Curator, of the Economic Section, Indian Museum, and the following results, obtained by him from some of the first extracts prepared by forest officers in the forest, and without machinery, may be interesting :

Name of material.	Dry extract.	Tannin.	Tannin in dry extract.
1 Terminalia chebula, fruit ...	6.4	3.6	56.2
2 " myriocarpa, bark ...	3.4	2.79	82.0
3 Shorea robusta, bark ...	7.9	3.9	49.8
4 Quercus lamellosa, bark ...	5.0	2.72	54.4
5 Terminalia myriocarpa, bark ...	4.0	2.68	67.0
6 Engelhardtia spicata, bark ...	6.0	5.08	84.6
7 Terminalia myriocarpa, bark ...	75.4	29.1	38.6
8 " chebula, bark ...	51.8	29.0	55.9
9 " " fruit ...	59.4	98.4	47.8
10 Shorea robusta, bark ...	63.6	26.8	42.1
11 Acacia catechu, bark ...	70.4	40.8	57.9
12 Terminalia tomentosa, bark ...	68.2	26.35	38.6
13 Engelhardtia spicata, bark ...	65.0	44.0	67.7
14 " " bark ...	2.9	2.56	88.0
15 Terminalia chebula, fruit ...	7.8	4.82	61.7
16 " " bark ...	2.0	1.43	71.5
17 " myriocarpa, bark ...	2.8	2.6	92.8
18 " tomentosa, bark ...	8.3	7.53	90.7

The following report by Mr. Hooper may, with advantage, be quoted *in extenso*.

"In submitting a report on the examination of certain tannin extracts received from Forest Officers at Saharanpur, Nimar, Central Provinces, Coorg, and Burma, I would offer the following remarks on their physical properties and chemical composition.

"Most of these extracts were received in a liquid condition, and in a few cases the fermentation and development of carbonic acid gas had burst the bottles, and the contents were lost. Other extracts were in a thick syrupy state, and the rest were soft and sticky. None were hard and friable, as one would expect to see in cutch substitutes. The watery solutions appeared to have been made with some care, although the methods of preparation were not carried to completeness. The barks and leaves were immersed in hot water for definite periods, but in several instances no attempt was made to concentrate the resulting liquors.

"No data were afforded by some of the officers for calculating the amount of extract from the crude material, and even where weights and measurements are recorded, a considerable loss of extract is indicated. For instance, in calculating the amount of solid extract from the raw products used in Nimar, Central Provinces, the bark of *Terminalia Arjuna* is shown to yield 8 per cent. of extract, the leaves of *Anogeissus latifolia* 6·7 per cent., and the leaves of *Phyllanthus Emblica* 10·7 per cent. These figures are very low and do not reach the estimated proportion of pure tannin actually found in these materials.

"The extracts obtained from fruits and leaves are, from my experience, not so satisfactory as those made from the bark of the tree. Leaves always contain more mineral matter than bark, and salts of potash are at once removed on treatment with water. Fruits, on the other hand, contain considerable proportions of uncrystallisable sugar which is readily dissolved out with the tannin. These two substances, potash and sugar, give the finished extract a hygroscopic consistence which makes it difficult to powder. The bark preparations are more free from those substances which absorb moisture from the air, and on this account are not so liable to turn mouldy in damp weather.

"The liquid extracts, provided they were manufactured from authentic sources, have supplied material for approximately determining the value of the more solid extracts. A decomposing fluid, with a mouldy surface and a more or less bulky deposit, is not the best medium for investigation; but by ascertaining the amount of solid matter in a measured volume of the clear liquid, and the amount of tannin in another portion, very concordant results were obtained. In the

' following form, these results are tabulated. The first column of figures shows the actual percentage of residue (dried in 100° C.) in the liquid; the second column gives the amount of tannin in the liquid, and the third column records the percentage of tannin calculated on the dry residue. Most solid extracts naturally hold from 5 to 20 per cent. of water, so it must be remembered that the tannin in the third column of the table is calculated on the absolutely dry extract, and is, therefore, higher than it would be if determined in an ordinary commercial sample."

Analyses of liquid extracts obtained from Tannin materials.

Register No.	Name of tree.	Part used.	District.	Percent- age of dry extract.	Percent- age of tannin.	Percent- age of tannin in dry extract.
10000	Phyllanthus Emblica	.. leaves	Nimar, Central Provinces.	11.5	6.48	56.3
10001	Anogeissus latifolia	.. bark	do	8.0	3.08	51.3
10002	do do	.. leaves	do	34.2	10.0	84.4
10003	Terminalia Arjuna	.. bark	do	4.84	3.56	78.5
10013	Pterocarpus Marsupium	.. do	Coorg	8.94	3.48	90.4
10014	Terminalia paniculata	.. do	do	2.2	1.7	75.4
10015	do tomentosa	.. do	do	8.0	2.3	76.6
10016	Santalum album	.. do	do	1.0	Inappreciable.	
10016(a)	do	.. wood	do	..	..	..
10017	Eugenia Jambolana	.. bark	do	95	41	48.1
(10021a)	Acacia ferruginea	.. do	do	..	..	..
10021	do do	.. fruit	do	45	Traces	only.
10018	Terminalia belerica	.. do	do	3.24	1.55	47.0
10019	Phyllanthus Emblica	.. do	do	1.74	1.21	69.5
10020	do do	.. bark	do	1.3	77	59.2
10022	Caesia Fistula	.. do	do	2.1	1.30	61.0
	Spondias mangifera	.. do	do	..	..	..
10023	Schleichera triflora	.. do	do	2.8	1.58	58.8
10024	Dalbergia latifolia	.. do	do	1.0	20	20.0
10025	Anogeissus latifolia	.. leaves	do	1.0	81	61.4
10026	Lagerstromia microcarpa	.. bark	do	1.1	81	28.1
10027	Lantana	.. fruit	do	1.9	Traces	only.
10028	do	.. bark	do	2.2	do	do
10029	do	.. leaves	do	6	do	do
10151	Garuga pinnata	.. bark	do	5.2	3.7	10.7
10152	Briedelia retusa	.. do	do	7.0	4.13	59.0
10153	Buchananla latifolia	.. do	do	9.8	5.4	55.1
10154	Butea frondosa	.. do	do	5.2	1.84	85.3
10155	Careya arborea	.. do	do	4.32	2.97	72.0
10156	Lagerstromia parviflora	.. do	do	6.2	4.84	72.2
10151	Garuga pinnata	.. do	do	4.9	3.26	66.5
10152	Briedelia retusa	.. do	do	6.2	4.07	65.6
10153	Buchananla latifolia	.. do	do	16.4	10.42	63.5
10154	Butea frondosa	.. do	do	5.2	1.84	85.3
10155	Careya arborea	.. do	do	6.7	4.22	68.0
10156	Lagerstromia parviflora	.. do	do	5.2	3.50	67.3
10148	Thetta Sandoricum indicum	.. do	Burma	4.98	3.20	64.2
10149	Psidium Guava	.. do	do	11.4	5.74	70.4
10150	Kamyino Dipterocarpus	.. bark	do	8.48	6.46	76.1
10164	Lagerstromia flos-reginas	.. root	do	1.37	No	tannin.
18174	do tomentosa	.. do	do	1.42	57	40.1
10177	do microcarpa	.. do	do	1.13	No.	tannin.

Solid extracts from Saharunpur.

Register No.	Name of rec.	Part used.	Water.	Tannin.	Moisture in water.	Ash.	Tannin in dry extract.
100003	<i>Bhorea robusta</i>	.. bark	13.2	16.0	28.0	14.2	18.4
100004	<i>Cassia Fistula</i>	.. leaves	15.0	24.2	17.5	10.0	28.4
100005	<i>Terminalia tomentosa</i>	.. bark	12.2	35.4	13.8	8.7	40.3
100006	<i>Anogeissus latifolia</i>	.. leaves	13.8	22.0	32.4	9.4	25.5

' In discussing the results of the analyses many interesting points may be noticed. The tree yielding Malabar Kino (*Pterocarpus marsupium*) is shown to yield the richest extract. The estimation was performed in duplicate, and the tannic acid was found to be very pure. The barks of various species of *Terminalia* are particularly astringent. The species *arjuna*, *paniculata* and *tomentosa* contain over 70 per cent. of tannin in their extracts. The richness of these *Terminalia* barks should be considered in connection with the recent enquiry of the Director of Kew Gardens with reference to *T. Oliveri*. The barks of *Garuga pinnata*, *Careya arborea*, *Bridelia retusa* and Kamyine (*Dipterocarpus*, sp.) compare most favourably with well-known tanning materials as far as their composition is concerned. An interesting feature in these experiments is the astringent nature of the barks of certain species of *Lagerstræmia*. *L. parviflora* is mentioned in the Dictionary of Economic Products as yielding a dyeing and tanning bark, and in the table the extract is shown to justify such a use from the large proportion of tannin it contains. The bark of *L. microcarpa* Wight (*L. lanceolata*, Bedd.) and the root of *L. tomentosa* afford much smaller quantities.

' It might be noticed that the liquid preparations from *Guava* bark, *Eugenia jambolana* bark and *Anogeissus* leaves were very insoluble in water after they had been evaporated to dryness, indicating that the heat employed had effected a chemical change in the constituents.

' In order to utilize the results of the analyses for selecting the best materials for making tannin extracts, I should reject all barks and leaves giving less than 50 per cent. of tannin in their extracts and choose the richer kinds for further experiment. Cutch of various kinds, mangrove extracts, and other preparations afford 50 per cent. or more of pure tannin, and it would not be desirable to adopt a lower standard.

' Liquid extracts containing tannin are liable to deteriorate on keeping. The six preparations from Coorg bearing registration Nos. 10151 to 10156 were sent in duplicate; the

' first series were sent direct from the Deputy Conservator of Forests early in November, and the second series came through the Conservator of Forests, School Circle, Dehra Dún, and was analysed about six weeks afterwards. The results show that three samples had become weaker, two were stronger, and only one was of the same strength as the corresponding liquid received in the first consignment.

' The solid extracts from Saharanpur (Register Nos. 10003 to 10006) contained large amounts of extraneous matter insoluble in water. It would appear that they had been over-dried or burnt in the course of manufacture. The extract from the bark of *Terminalia tomentosa* was decidedly the best of the four samples."

Some good extracts were made in the Sandarbans Division by Mr. Dingwall Fordyce from the bark of *Cerriops Condolleana*, *Cerriops Roxburghiana*, *Kandelia Rheedii*, *Bruguiera gymnorhiza*, *Rhizophora mucronata*. These extracts were analysed by Mr. Hooper with the following results.

Register No.	Source of extract.	Moisture.	Ash.	Insoluble in water.	Sand.	Tannin.	Tannin in dry extracts.
10281	<i>Cerriops Condolleana</i>	14.2	14.3	9.7	(5.7)	53.9	61.6
10284	<i>Cerriops Roxburghiana</i>	13.9	15.3	9.8	(5.3)	53.5	62.1
10287	<i>Kandelia Rheedii</i>	19.5	18.6	14.6	(6.1)	44.5	55.2
10290	<i>Bruguiera gymnorhiza</i> , Kankra	19.9	17.4	8.2	(3.2)	57.0	71.1
10293	<i>Rhizophora mucronata</i> , Bhara	11.0	14.5	13.5	(4.6)	29.8	33.5

A large number of extracts have also been tested at the Forest School at Dehra by the Assistant Agricultural Chemist, and the analyses made by him generally corroborate the results obtained by Mr. Hooper.

The next step in the enquiry was a conference held in Calcutta between the Inspector-General of Forests and the Reporter on Economic Products in January 1898, at which it was decided that enquiries should, for the present, be limited to such trees as gave fair promise of yielding extracts of commercial value. Judging from the preliminary experiments, these trees were considered to be :—

- (a) *Acacia arabica*.
- (b) „ *Catechu* (Chips of wood).
- (c) *Shorea robusta*.
- (d) *Terminalia tomentosa*.
- (e) *Anogeissus latifolia*.
- (f) *Cassia Fistula*.

- (g) *Cassia auriculata*.
- (h) *Phyllanthus Emblica* (fruits).
- (i) *Pterocarpus Marsupium* (bark from trees felled and of branches, &c).
- (j) *Xylia dolabriformis* (waste wood, sawdust and branches)
- (k) *Ceriops Candolleana*.
- (l) *Terminalia Chebula* (fruits from Burma).
- (m) *Pinus longifolia*.
- (n) *Casuarina equisetifolia*.
- (o) *Acacia leucophloea*.
- (p) *Briedelia retusa* or *B. montana*.
- (q) *Kandelia Rheedii*.
- (r) *Bruguiera gymnorhiza*.
- (s) *Rhizophora mucronata*.
- (t) *Ceriops Roxburghiana*.

Attention was called to the advisability of testing and analysing the raw material as well as the extract therefrom. A quantity of bark, etc., of the trees above-mentioned was accordingly supplied to the Reporter on Economic Products and analysed by Mr. Hooper with the following results.

Tannin values of Indian barks.

		Tannin.	Extract.	Moist- ure.	Ash.
<i>Terminalia chebula</i> , bark, R. No.	11409	28.6	31.2	11.7	10.1
<i>Rhizophora mucronata</i>	do 10759	26.9	40.0	10.9	9.2
<i>Ceriops candolleana</i>	do 10282	26.2	28.0	13.3	10.6
<i>Cassia auriculata</i>	do 10746	23.0	32.8	11.1	5.9
<i>Ceriops Roxburghiana</i>	do 10285	19.2	27.8	9.2	18.0
<i>Acacia dealbata</i>	do 11389	17.8	23.6	12.1	4.6
<i>Acacia arabica</i>	do 10586-1	16.7	26.0	9.8	10.9
<i>Acacia leucophloea</i>	do 10579	16.2	26.0	7.4	9.8
<i>Bruguiera gymnorhiza</i>	do 10291	15.9	21.2	9.6	7.3
<i>Briedelia retusa</i>	do 10639	15.9	18.6	9.5	11.0
<i>Pinus longifolia</i>	do 10581	14.6	26.3	8.9	3.9
<i>Kandelia Rheedii</i>	do 10288	12.2	17.7	9.9	9.8
<i>Casuarina equisetifolia</i>	do 10482	11.1	14.4	10.3	4.9
<i>Cassia fistula</i>	do 10977	9.5	27.9	11.2	11.0
<i>Acacia Catechu</i> wood,	10978	6.8	14.3	5.5	1.5
<i>Pterocarpus Marsupium</i> do	10585	5.4	7.0	10.2	12.9
<i>Shorea robusta</i> N. W. P.					
old trees do	10975	10.0	19.2	11.6	8.4
Ditto Coppiced trees do	10975-1	10.5	21.0	12.4	6.5
Ditto Assam, mature do	11093	13.2	21.2	11.4	6.0
Ditto Old branches do	11093-1	2.8	6.3	13.5	5.1
Ditto C. P. Ditto do	11035	6.7	16.3	7.2	10.5
Ditto Old trunk do	11035-1	4.6	7.5	9.5	6.0
Ditto Young coppice trees do	11035-2	7.1	11.2	10.1	4.0

Tanin values of Indian barks—(continued).

		Tannin.	Extract	Moist- ure.	Ash.
<i>Terminalia tomentosa</i>					
N.-W. P. old trees bark, R. No. 10976		11.8	20.5	12.6	25.0
Ditto coppiced trees do 10976-1		12.3	26.0	19.4	22.0
Ditto Old branches do 10976-2		13.6	19.7	10.0	20.7
Ditto Assam mature trees do 11094		8.6	15.5	11.8	12.5
Ditto Old branches do 11094-1		5.7	7.5	12.0	24.4
Ditto C. P., Old bark do 11034-1		26.2	28.7	10.4	21.6
Ditto Young coppiced trees do 11034-2		12.6	16.0	9.1	29.5
Ditto Old branches do 11034		11.7	17.3	9.2	17.1
<i>Xylia dolabriformis</i> saw. do 11442		6.1	7.0	9.1	2.4
Ditto dust do 10442-1		5.4	6.0	8.0	4.1
Ditto Chips do 11408		.8	1.0	20.8	2.2
Ditto Sawdust do 11408-1		4.6	5.7	5.6	2.9

Arrangements were next made to ascertain the market value of the extracts made in India, as compared with those in actual use in Europe. Some samples of extracts of Pyinkado, etc., were sent to Germany by favour of Messrs. Von Ernsthausen and Co. and were analysed by Drs. Popp and Becker, authorised trade Chemists and Analysts of Frankfurt. The best sample contained 37.24 per cent. of tanning agents and too much coloring material was present. The opinion was given that extracts containing so low a percentage of tannin could not compete with those at present in use in the German market. The extract in use which contains the lowest percentage of tannin is that of Quembracho, which contains 43.2 per cent. of tanning agents; and this can be bought in Germany at 33 marks per 100 kilogrammes, or say, Rs. 9-1-5 per maund or Rs. 247-8 per ton.

Further reports were obtained by favour of Messrs. Ernsthausen from Messrs. Schönbank and Sons, of Berlin. The following shows the results of analyses made by them.

	Acacia arabica bark.	Acacia arabica pods.	<i>Terminalia</i> <i>tomentosa</i> bark.	<i>Terminalia</i> <i>tomentosa</i> bark.
Tanning agents	30.00 %	22.80 %	52.50 %	23.40 %
Non-tanning soluble substances	24.40 „	34.10 „	27.10 „	33.40 „
Insoluble	6.20 „	8.40 „	6.60 „	31.60 „
Water	39.40 „	34.70 „	13.60 „	11.60 „
	100.00	100.00	100.00 „	100.00

And they compare this with the analysis of tannin extracts procurable in Germany which is as follows :—

	Liquid extract of Oak wood,	Liquid extract of Chestnut.	Liquid extract of Quem- bracho,	Solid ex- tract of Quem- bracho.
Tanning agents	28·60 %	30·40 %	33·80 %	68·50 %
Non-tanning soluble agents ..	13·70 „	8·20 „	2·40 „	5·40 „
Insoluble agents	2·20 „	1·80 „	3·20 „	6·80 „
Water	55·50 „	59·60 „	55·60 „	19·30 „
	100·00	100·00	100·00	100·00

Messrs Schönbank and Sons, report that the extracts from *Terminalia tomentosa* are too dark in colour and require to be decolorated before they can have any chance of finding a market. Further, they state that the samples contain far too large a proportion of non-tanning soluble substances, from 21·40 per cent. to 34·10 per cent. as compared with 2·40 per cent. to 13·70 per cent. in the extracts used in the trade, and they conclude that in order to render it possible for tanning extracts made in India to find a market in Europe, it is absolutely indispensable that they should be prepared in a rational, up-to-date manner, that the colouring matter should, as far as possible, be removed from the liquid solutions before condensation, and that these should be condensed in a vacuum.

These reports show clearly that the preparation of extracts in a rough and ready way in the forests is but a waste of time and money. The question of importing modern machinery is under consideration; the methods by which the solution may be decolorated is being investigated and in the meantime experiments are being continued at the Forest School at Dehra.

Extracts are now being carefully prepared and are being forwarded to the Reporter on Economic Products, who has been good enough to undertake to analyse and report on them. Samples of the extracts made at the School will also be forwarded through the Reporter on Economic Products to the Imperial Institute, where they will be examined and reported on, and further inquiries will be prosecuted in Europe.

It must be observed that simultaneously with the inquiries and investigations which, during the last few years have been carried out by the Forest Department under the orders of the Inspector-General, inquiries have also been set on foot by the Imperial Institute regarding tanning extracts, more particularly from the various species of the Indian Mangroves; "Tanning materials" also form the subject of Imperial Institute inquiry (No. 46 in the Report on Collections for 1895-96) and the tanning properties of *Terminalia Chebula*, *Acacia arabica*, and *Cassia auriculata*, as well as the influence of the locality and degree of maturity of the tree or the fruit, have since then been under special investigation.

In 1898 the Inspector-General of Forests wrote:—

"The main justification for the preparation of tannin extracts near centres of the production of tanning agents, in preference to places where the material is used, is that they contain, or should contain, a much larger percentage of tannin for the same weight, than the raw material, and are much less bulky to transport. If these advantages are not obtained to a very considerable extent, it would be very much simpler to send the bark or wood, chipped or powdered, direct to the tanneries, and to let the tanners make their own liquor.

The questions which we have to solve are:—

(a) "Whether we can, at a remunerative cost, make extracts which meet these requirements, and which, at the same time, contain no such extraneous matter as would render them in any way unfit for, or less valuable for practical tanning, than the raw material from which they are prepared.

(b) "Whether we cannot, in making these extracts, remove, at a remunerative outlay, some of the properties found in some of the raw material, which render this less desirable for tanning than others.

"This refers more especially to the bark of *Shorea robusta* and *Terminalia tomentosa*, of which enormous quantities are available. Both of these, however, tan very dark, much more so than *Acacia arabica* and *Cassia auriculata*, and are consequently, only used in admixture with less highly coloured material."

What is required is, in fact, a more correct knowledge of how to prepare our extracts, so that European tanners will pay a remunerative price for them. We know that we have in our forests any quantity of materials containing tannin which, in most cases, simply goes to waste; and we have found out the materials which are likely to prove the most valuable. It remains to surmount the difficulty of correctly preparing the tannin extracts, and of placing them before the public in a marketable form at a remunerative price,

Mica in Bengal.

From a paper dealing with the mica mines in Bengal, contributed by Mr. A. Mervyn Smith at the meeting of the Institution of Mining and Metallurgy on February 15th, it appears that the industry is a very ancient one, the methods of mining the mica and preparing it for market having been in use for centuries. The mica occurs in pegmatite veins running through foliated rocks, and is taken out from open cuts made in the decomposed granite, and abandoned as soon as solid rock is reached. The miners are a local tribe called Bandathis, men, women and children all working at the mines in the dry months when there is no agricultural work in the fields to be done. The books of mica are chiselled out, the work being aided by large fires when the pegmatite is hard, and split into sheets of about one-eighth of an inch in thickness. The rough edges are then trimmed, and the sheets sorted into four qualities and several sizes; the best "ruby" mica, which is unaffected by high temperatures, being worth 20s. per pound when in large sheets, while small sheets only fetch 2d. per pound. The uses are well known and the consumption is now increasing, but appears to have been greater in early times. The output was given by Dr. McClelland in 1849 as 100,000 maunds, or about 73,000 cwts., and is estimated by Mr. Mervyn Smith at less than 20,000 cwts. in 1895. He also states that nearly all the mica used in the arts comes from these mines.

NATURE,
February 3rd, 1899,

Removal of *Cryptococcus fagi*.

To rid beech trees of that dangerous parasite, *Cryptococcus fagi*, which causes much anxiety to foresters, many methods have been tried. Solutions of soft soap, methylated spirit, and so on, applied to the skin of the tree, are of no avail when the bark has become much decayed. External remedies having in such cases proved useless, Mr. John Shortt, the head forester upon the estate of Sir Matthew White Ridley, Bart., has tried internal ones, and the results are mentioned in the recently-published volume of *Transactions* of the English Arboricultural Society. Thirty years ago, several trees which were in the last stages of decay were selected, and three holes were bored in the trunk of each, about two feet from the ground, standing downwards, and converging towards a common centre. Sulphur, saltpetre, and other substances were placed in the holes; sulphur in one tree, saltpetre in another, and something else in a third, and the holes were then securely plugged. All the trees died except the one that had been treated with sulphur. Since these experiments, several other beeches have been treated in the same way, and with equally satisfactory results. The operation, it may be added, is performed in the autumn. These experiments in practical forestry have excited great interest among foresters. It is hoped that the matter will be taken up in a scientific way, and that the chemical action of the impregnated sap will receive elucidation in a form which will be of practical use to the owners of woodlands throughout the country.

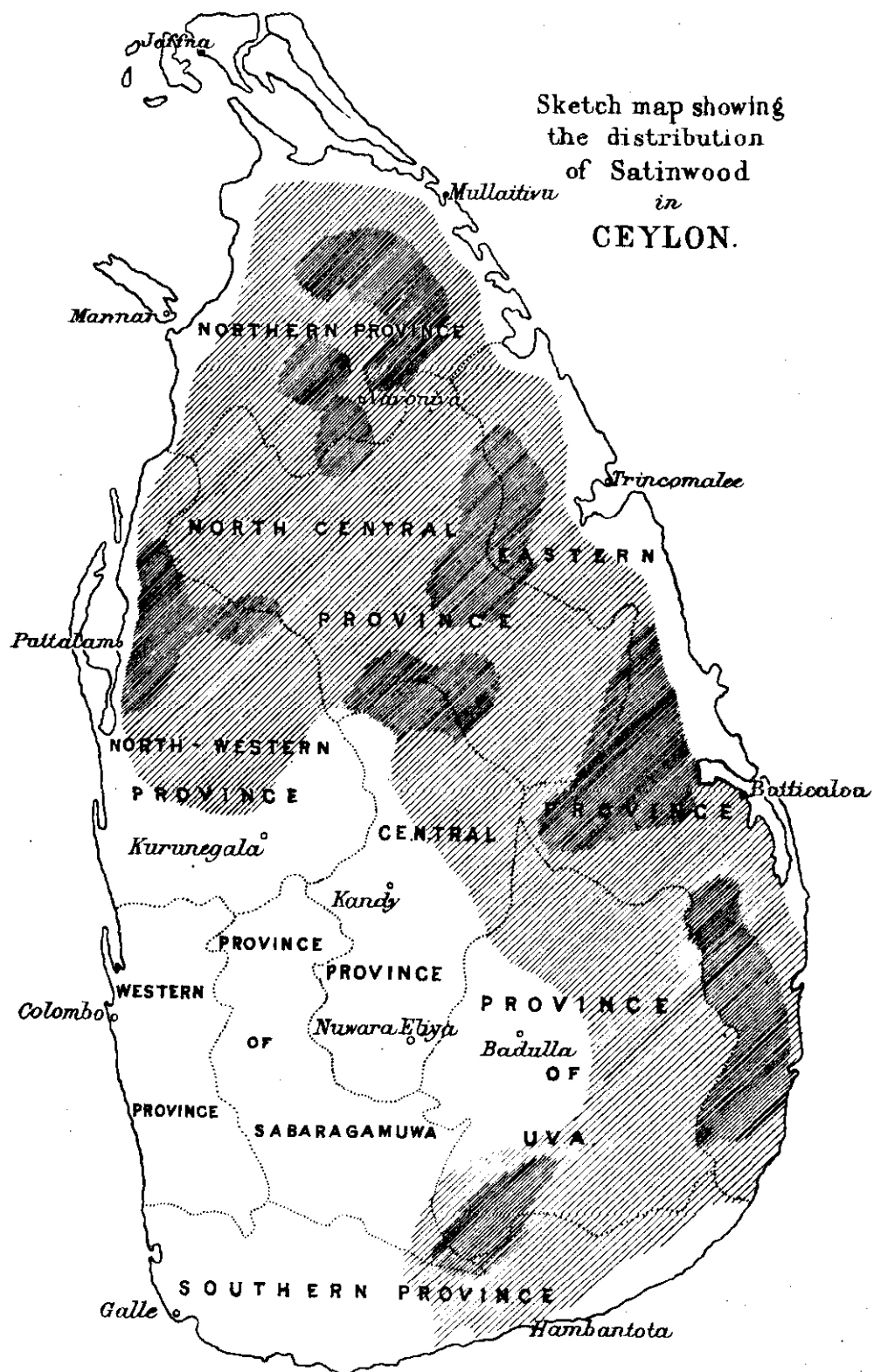
NATURE.

February 23rd, 1899.

Timber Seasoning by Electricity.

We extract the following from the *Engineer*.

During the last few years considerable attention has been given to the invention of new processes for treating timber. The latest aspirant to fame is a process and apparatus which claims to give to timber properties which time alone has so far been able to produce. It is a French idea, and has, we are informed, met with considerable success in Paris, where works have been established to treat timber on a large scale. The Nodon-Bretonneau process involves the expulsion of the sap and its replacement by a solid matter, insoluble and aseptic. This is effected by placing the material to be treated in a vat containing a lukewarm solution made up of borax, 10 per cent; resin 5 per cent; and .75 per cent. of carbonate of soda. While in this bath, an electric current of about 100 volts pressure is caused to pass through the timber. The current sets up what is termed electro-capillary attraction, and drives out the sap by the introduction of the solution. This treatment lasts from six to eight hours generally, after which the wood is subjected to a further treatment of a few hours' duration in a warm bath to allow of thorough permeation of the entire section. It is then removed and dried under cover by air currents, a process which is said to take from fourteen days to a couple of months, according to the density and thickness of the material. The inventors claim that not only is a considerable saving in time and expense in the drying of timber effected by this process, but that certain classes of wood, such as maritime pine, which have not hitherto been readily saleable owing to the large amount of moisture they contain, can by its use be readily deprived of the sap. The expenditure of electric current is said to be 600 watts per cubic metre per hour for five hours. The Electric Timber Seasoning Company, Victoria-street, Westminster, is introducing the system into this country, and a model apparatus has been fitted up at the works of Messrs. Johnson and Phillips, Charlton Junction.



N.B. The more important forests are indicated by denser shading.

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[No. 5.

Satinwood.

CHLOROXYLON SWIETENIA D. C.

Brandis in his "Flora of North-West and Central India" thus speaks of this tree:—"A common tree in the Satpura Range, the Dekkan, the Konkan, and the drier parts of the peninsula and Ceylon. A small tree in Central India, in South India attaining 30-40 ft.; trunk straight, symmetrical. Bark yellow, soft, corky, $\frac{1}{2}$ in. thick or more. Heartwood, with a beautiful satin lustre, fragrant, when seasoned, greenish white with a yellow tinge, or yellow, mottled, and feathered, close grained. Heavy, the cub. ft. weighs 51-66 lbs. when seasoned, and 70-75 lbs. when green. The value of P. has been found to fluctuate between 600 and 1059, and the average may be taken at 800. Has been compared to box, not found suited for engraving, but is excellent for turning. Employed for agricultural implements, cart-building, makes beautiful furniture and picture-frames. Imported into England, used for cabinet work and the backs of brushes."

My experience of Satinwood in India being most limited, my remarks apply mainly to this tree in Ceylon, where it attains its best dimensions.

Distribution:—The annexed sketch map shows, roughly, the distribution of this tree over the island. It will be seen that it is only absent from the South-Western portion, *i. e.*, from the portions affected by the South-Western monsoon, and from the higher mountain ranges. I have seen some trees at an elevation of about 1500 feet in the Province of Uva, and a few trees in the intermediate rainfall zone near Kurunegala, but, as a rule, it can be said that it is not found above an elevation of 800 feet, and in localities with a rainfall of over 65 inches. The finest forests are in the Northern portions of the Batticalon District, and in the Puttalam District. In the Northern portion of the island, the trees, although abundant, do not attain very large dimensions.

Soil:—Satinwood requires a light sandy soil with good subsoil drainage. It is also found on well-drained rocky hills, if there is not too much clay in the soil.

Sylvicultural requirements:—This tree is essentially a shade-avoiding tree, except perhaps in its infancy when, like other trees, belonging to the natural order of the Meliaceæ, it prefers side-shelter or low cover. It springs up readily in clearings, but is also found along the sides of forest roads and lines or growing in the midst of bushes in old clearings abandoned by the chena cultivator. In this respect it is a valuable re-afforesting agent; for, after the chena cultivator has cut and burnt off the jungle and cultivated it for two or three years, a rank growth of spiny and prickly bushes springs up, which the Satinwood helps in again becoming valuable forest. In high forest, especially if the leaf canopy is not dense, or if it is not high, Satinwood seedlings germinate readily enough, but they require the aid of man to develop into trees. It is for this reason that in Ceylon forests of a certain age, although large and medium-sized trees are not uncommon, there is a remarkable absence of saplings and poles. This has led Mr. Vincent, in his valuable Report on the Ceylon forests, to state that the natural reproduction was poor. The contrary is, however, the case; but up to recently the Government did not do anything to replace the trees taken away by helping the young seedlings, and no cleanings or seed-fellings have been carried out. It appears to me that the correct treatment for Satinwood is to girdle trees for some distance to leeward of the seed-bearers, in sufficient numbers to give light to the soil without encouraging the growth of rank grass and weeds, and far enough to let the light seed, which is carried to some distance by the wind, have a chance of developing into seedlings. As the seed ripens before the North-East monsoon, the girdling should be done early in the year, and at the same time all large climbers which invade the crowns of the trees should be cut. After the seed has germinated and the seedling established itself, it requires direct overhead light, and this should be provided, but caution must be exercised in not girdling too many of the dominant trees, for this might lead to an invasion of insects which would be liable to attack the seedlings as well as the girdled trees.

Dimensions and rate of growth:—Satinwood grows to a large tree, except in wind-swept localities near the sea, where it attains only small dimensions. The crown is large, as can be expected with its light, feathery foliage; the bole, although it attains a girth of 8 or 9 ft. is usually comparatively short, i. e., rarely over 30 feet in height. This is due to the requirements of light by the tree which early forms branches in order to develop a large crown. As regards the rate of growth of the tree, the data which we have at present are unfortunately

not very reliable on account of the small number of trees in each sample plot and in consequence of the habit of mixing up trees of different girth-classes, and of calculating the average girth for all. This method of measurement has now been given up and the trees are measured by girth-class, and it is hoped that in a few years reliable data will be obtained. I have gone carefully into the figures available and the following appear to me to give a fairly correct idea of the rate of growth of an average Satinwood tree.

Age of tree	18 inches in girth	...	20 years.
"	" 3 feet	...	45 "
"	" 4 ft. 6 in.	...	75 "
"	" 6 feet	...	125 "

If this estimate of the rate of growth proves to be correct, it takes 50 years for a tree 4 ft. 6 in. in girth to reach a circumference of 6 feet. If, therefore, the exploitable size is taken at 6 ft., as it is now in Ceylon, it would be proper under the Selection Method of treatment to go over the forest in 50 years, taking all the trees 6 ft. and over which can be spared from a silvicultural point of view. In old forests, it would be better still to go each year, on an average, over one twenty-fifth of the area, taking only one-half of the exploitable stock or confining operations to trees whose removal is most urgent.

We have not yet sufficient experience to know, in the event of the Regular Method being adopted, how many years before the final fellings the seed-fellings should be made. Observations made in our forests since 1891, show that the Satinwood flowers abundantly every year and it is probable that seed-fellings made some 7 to 10 years before the final fellings, would give a good crop of seedlings.

Enemies.—This tree, like others belonging to the same natural order, is liable to attacks from insects which bore into the pith of the young shoots. A large number of trees die from the attacks of the larva of a beetle, probably a longicorn, which makes galleries between bark and wood, that not unfrequently girdle the tree. The young saplings are very liable to injury by stags, since these prefer them to any other trees for rubbing off the velvet from their horns. This preference is probably due partly to the corky nature of the bark and partly to the gum, which exudes from wounds and soothes the irritation which the animals feel. In some parts of the island the trees are liable to the attacks of a fungus, which rots the centre of the tree and causes a clean hole, sometimes throughout the length of the bole. This is the case particularly in the South-Western portion of the island. Satinwood does not resist fires well.

The timber.—The weight of 12 well-seasoned pieces taken by me from different parts of the island, varied from 55.2 lbs. to 65.4 lbs. per cub. ft., and the average was 59.92 lbs. per cub. ft. This is a somewhat higher average than that of the specimens

tested by Mr. Smythies in 1878, which averaged 57 lbs. Seasoned wood can, therefore, be said to be lighter than water. The wood is hard and strong, takes a beautiful polish, and is extremely durable. The most valuable wood is that which is known in Ceylon as "flowered," and in the home market as "figury" wood, especially if it is light-coloured and can be used together with West Indian Satinwood. The price of flowered Satinwood in Colombo ranges from Rs. 4 to Rs. 7 per cub. ft. in the log. It has not yet been ascertained what the figure in the wood, which is merely curly fibre, is due to, and whether it is hereditary. It was found in some abundance in one of the forests of the Pattalam District, which was exposed to the full blast of the monsoons and wind may have something to do with it, but I think that it must be due also partly to the soil. There is streaky and curly flower, and it is the latter which gives the prettiest effects of satin-like lustre and which fetches the best prices in the market. Unflowered satinwood fetches prices up to Rs. 2.50 per cub. ft. according to colour and size of the logs. Light-coloured logs are preferred although the darker ones are better for patching up old cabinet work. Logs of a dull, muddy colour are not appreciated. The best logs as regards colour and size are now obtained from the forests in the East of the island. Fine logs used to be obtained from Pattalam, but these forests have been more or less exhausted by timber traders in the old days. The finest logs I have seen were 8 to 9 ft. in girth.

The logs for the home market are sent to the Central Timber Depôt in Colombo, where they are tested for "flower," and the flowered logs set aside. Hitherto they have been sold according to market rates; but in future, on account of the great demand for flowered logs, the latter will be sold by auction. The proportion of flowered logs is not much above 5 per cent. Satinwood is also sold at the Forest Depôts or, when possible, standing in the forests. This has been the case in the Eastern provinces, where first class logs have been stamped over one-sixtieth of the area, but the sale of the *coupes* was effected after the picked logs had been felled and sent to Colombo.

The strength of the wood has not yet been tested with pieces of a proper size, the largest specimens tested having, according to Gamble, a cross-section 2 in. square. I have not much faith in tests made on pieces of timber which may be taken from any part of a log, and should like to see the example of the University of Sidney followed, where Professor W. H. Warren tests pieces of timber of the dimensions ordinarily employed for construction. According to Gamble the value of P. varies from 504 to 1,059, but I think that, on an average, it will be nearer 1,000 than 500.

The uses to which this timber is put in Ceylon are the following :—

Cabinet work and furniture. Satinwood' furniture is, however, heavy; and is really suitable only when finely made, as in the case of Chippendale patterns. In cart-building it is used for the naves and spokes of heavy carts. It has been much used for house and bridge building, and the bridge at Peradeniya, near Kandy, consisting of a single arch 205 ft. wide, is built entirely of this wood. Ball-room floors made of Satinwood are considered good, but to my mind they are too hard, wanting in elasticity and much too slippery for dancing. Sleepers made of this timber have lasted over 20 years on the Ceylon Government Railway, and experiments are now being carried out in the new Colombo Harbour-works to test its resistance to the *teredo*. The pieces have only been put in position a year ago, but so far they are intact. In the North of the island the wood is used for oil mills; and in the Eastern province, hollow logs are in great demand for wells. Ploughs are usually made of this wood.

Minor products.—According to the Dictionary of Economic Products, this tree yields a yellow dye and a wood-oil. I have, however, never heard of these products being employed in Ceylon. The bark, like that of other Meliaceæ, has medicinal properties, and a gum exudes from it which might prove to be a good substitute for gum arabic.

COLOMBO :

28th March, 1899.

A. R. BROWN.

The treatment of Bamboo Clumps and Bamboo Forest.

This very important question is one which has been much discussed, and which requires to be permanently settled. But the first point of importance, which must precede all further discussion of the question, is one which has sometimes been overlooked. That point is that, in order to be able to make one's mind clear as to the data upon which to speak or write, we must give up talking of "*the* bamboo" or "bamboos" generally and restrict ourselves to a consideration of each species on its merits. In a recent paper on the biology of Indian bamboos (*Indian Forester*, January 1899) Sir D. Brandis writes:—"To talk of the habits of bamboos

'and of the management of bamboo plants, has little meaning and is of no practical use. Each species has its own 'peculiarities and its own requirements." No one, who has any acquaintance with the chief species of our Indian forests, would think that the same treatment can be applied to the densely cœspitose, interwoven clumps of *Bambusa arundinacea* or *Dendrocalamus strictus* and to the open separately-stemmed forests (for the term "clumps" is here inapplicable) of *Melocanna bambusoides* or *Arundinaria racemosa*.

Bamboos, thus, in India as shown by Sir D. Brandis, may be divided into two classes:—

- (1) Those with short thick rhizomes which form regular closely-growing clumps.
- (2) Those with long, underground, thin rhizomes which send up isolated stems.

In (1) come such important species as:—

Bambusa Tulda
 " *Balcooa*
 " *polymorpha*
 " *arundinacea*
Dendrocalamus strictus
 " *Hamiltonii*
 " *Brandisii*
 " *giganteus*
Cephalostachyum pergracile.

while in (2) come especially:

Bambusa nutans
 " *burmanica*
Gigantochloa macrostachya
Melocanna bambusoides

The bamboos of class (2), of which the commonest and best known kind is *Melocanna bambusoides*, the "Mūli" of Eastern Bengal, and the principal one of those known as "Tabendoinwa" in Burma, as recently ascertained from specimens sent by the Conservator of the Pegu Circle, do not grow in regular clumps, but spread themselves over the country. Their treatment, therefore, seems to present no difficulty, except that I should think it would be advisable to restrict cutting to culms of one year old and older.

It is in the treatment of bamboos of class (1) that a difference of opinion has existed, and it is in regard to the chief forest species, viz., *Dendrocalamus strictus*, that the discussions have taken place.

Dendrocalamus strictus, the "male bamboo," is the sole indigenous species in the Siwalik Hills and Lower Himalayas of the Punjab and North-Western Provinces. It also occurs in large quantity right down the Western Peninsula, through the Central Provinces, Orissa, the Circars, Carnatic, Deccan and

Maharatta country ; it is absent from the greater part of Bengal and from Assam, but is found again in profusion in the forests of Burma, where it is known as "Myinwa." My own experience of it has been gained in Chota Nagpur and Orissa, in Bengal, and in the Madras Presidency, as well as in my present charge, the School Circle, N.-W.P. and Oudh. In Bengal it is worked from forests almost pure in the Palamau Division, and especially from the Kechki and Betlah Reserves. In Madras it is most largely worked in the forests of the Godavari, Kurnool and Cuddapah Districts. Here, in the Saharanpur and Dehra Dún Divisions, as well as in the adjoining Ganges Division of the Central Circle, it is perhaps the most important of all the products of the forests and the most valuable. It is, therefore, very necessary that its treatment should be understood and applied so as to lead to the largest production compatible with the improvement of the capital stock. The subject has consequently received great attention and has been discussed considerably, especially in reference to the preparation of Working Plans for the Dehra Dún, Ganges and Saharanpur Divisions.

In the Working Plan for the Dehra Dún Division the prescriptions were, that, if the work were done departmentally, all shoots under two seasons old should be left, and if by sale to purchasers, at least 8 shoots should be left of saleable dimensions. This was revised in 1892 and the forests divided into three sections.

- (1) Three blocks to be worked departmentally, together with the cleaning out of all congested clumps.
- (2) One block to be worked on permit for Hardwar basket work supply
- (3) The rest to be worked on a 2-years' rotation.

The time has now come, I think, to carry out the "cleaning" if possible throughout the forests and to substitute annual for biennial thinnings thereafter. The cleaning work has not been very well done. In Johra it has been overdone, but I think the clumps will recover though the thinnings for the next few years will be poor.

The Working Plan for the Ganges Division, prepared in 1888 by Mr. N. Hearle, contains in paras. 59 to 74 a long and interesting account of the bamboo forests and the systems of treatment to which they had been subjected, with a discussion of the arrangements for future working. The provisions are not very clear, but simply amount to the recommendation of yearly thinnings if possible, and if not possible, of working on a 3 years' rotation. The plan was revised in 1896, and in discussing the question of the best system to apply, and a strong recommendation made by Mr. A. G. Hobart-Hampden that the thinning of bamboos should be done yearly, the Conservator

of the Central Circle consulted me on the subject, and in reply I wrote on the 6th February 1896 (see page 76 of Inspector-General of Forests Proceedings for March 1896), giving my opinion and the history of my endeavour to improve the condition of the clumps in my Circle. That letter fully disposed of the general question as I understand it, but since 1896 we have progressed a great deal in the Saharanpur Division, and we are now gradually "cleaning" all the clumps with a view to introducing everywhere the system of annual "thinning," and instead of having to pay for this cleaning, as I wrote in 1896 to Mr Dansey, we can now make the work a profit to Government.

In the Saharanpur Working Plan the prescriptions are given in paras: 67 to 76 and the arrangements are these:—

- (1) Working the Maiapur Block for green bamboos for the Hardwar basket makers.
- (2) Working 6 Blocks on yearly thinnings after a preliminary cleaning.
- (3) Working the rest on biennial permits, the purchasers to cut under regulation, but if possible, the arrangement to be gradually changed to annual thinnings.

It was in the Ranipur Block that cleaning was first attempted. By a mistake many clumps were clean-cut so that they produced at first only thin shoots. The greater part of the bamboo area is under a Coppice Working Plan, and the result of the coppicing of the trees has been to give more light to the bamboos, so that they bid fair soon to almost monopolize the area. This is a good thing, as fuel is to be had in plenty from the hills behind, while the bamboo is much more valuable. The cleanings are being gradually carried out and in many clumps yearly thinnings are now in progress. Appended is a memorandum by the Divisional Officer, Babu Karuna Nidhan Mukerjee, on the system under which the cleanings in this and other Blocks are being done. It will be seen that the operation is being now made a source of revenue.

In my letter to the Conservator, Central Circle, already referred to, I described the work done at the Forest School with certain clumps there. This work has now been going on for several years, and I have watched the results very carefully. I have no hesitation in giving it as my opinion that the cleaning, followed by yearly thinnings, has:

- (1) increased the number of yearly shoots;
- (2) improved the quality of the shoots, which have now space to develop straight and healthy;
- (3) allowed of the removal, at will, of any single shoot or culm that it is desired to cut;

and I cannot help surmising that, under this system, the year of flowering can be postponed, perhaps indefinitely. Of course, it is not to be supposed that work in many square miles of forest can be carried out as neatly and carefully as it is in the Forest School Park, where the work is done by men who understand it fully, and with the saw instead of the axe; but without such neat working, a great deal can be done which will serve equally well.

That I am not alone in believing that annual thinnings are the best way to treat clumps, *i.e.*, forests of *Dendrocalamus strictus*, is clear from the remarks made by others who have studied the subject, such as Mr. E. E. Fernandez in his paper in the "Indian Forester," Volume XVII, page 186; Mr. Hobart-Hampden in his letter to the Conservator, Central Circle, in Inspector-General of Forests' Proceedings for March 1896, above quoted; Mr. N. Hearle in his Ganges Working Plan, and Mr. Dansey in various places, and last of all in his Annual Report for 1895-96, para. 100, copy of which is appended. In that extract, he considers that the possibility of the clumps flowering and dying off immediately after cleaning, is sufficient to condemn cleaning. There might, in my opinion, be something to be said for this view if the cleaning were expensive, but, as Babu Karuna Nidhan Mukerjee has now proved that it can be done profitably, the objection must fall to the ground.

The sum of my experience goes to show that in the treatment of large areas of valuable bamboo (*Dendrocalamus strictus*) forests, like those of the Saharanpur and Ganges Divisions in the N.-W.P.; of the Palamau Division in Bengal and of the Godavari Division in the Northern Circle of Madras, which I believe are the areas where there are the largest compact forests, near the market and easy of access and export, the first thing to do is to endeavour to bring the clumps gradually, by means of a "cleaning" of dry wood, old stumps, twisted and crooked culms, trees, bushes and climbers into a condition, in which the culms are fairly equally spaced throughout and each individual capable of being reached and cut without injury to the rest. This cleaning may with profit be done, as Babu K. N. Mukerjee does it, in connection with the yearly thinnings, so that the persons who carry out the work have an interest in it and are not liable to lose financially. If for instance, $\frac{1}{4}$ th of the clumps in any given area, in which the right of cutting is sold, are "cleaned," it will take 4 years to do the whole. In this cleaning, where the clumps are *very badly* congested, there must be overcutting the first year, but I have not found that this does any great harm, if the treatment in after years is judicious. So far as is possible, the last year's and the two-year-old culms should be the chief ones left, and everything cut should be cut to within 6 inches of the ground.

The next point of vital importance to remember is that, when a clump has been once cleaned, *annual thinnings* must be regularly made. I have known these thinnings omitted, because the Staff considered that rest was wanted after such severe treatment, with the result of a relapse into congestion. If the cleaning has had to be done very heavily, the next thinnings will naturally be light, but so made as to aim at bringing each clump into a condition, in which the standing culms are as regularly spaced as possible and all equally easily reached. In large forest areas, it is best not to attempt too much at once, but to do only that area which can be without doubt successfully done: the first few years' experience has to be gained; as it is gained and the Staff gets to know its business, the work will become easier and eventually, I am sure, the results will be apparent in an enormously increased supply of one of the most important articles of produce to the people of this country and in a great increase of revenue. A decrease in the latter at first will only be natural, and should not be allowed to frighten us from the right way.

What I have here described for the male bamboo (*Dendrocalmus strictus*) may, I think, be applied equally to any other species of the clump-forming class; but it must be noted that though *Bambusa arundinacea* was successfully treated by cleaning at Ballipalle in the Cuddapah District of Madras, in and about the years 1883 to 1888, this species is extremely difficult to clean, partly on account of its thorns and thorny side shoots, partly because the culms are weak and soft and unable to easily stand alone. But it is a bamboo of poor quality and its treatment by cleaning will be rarely attempted. In Burma, bamboos are usually too common and too much of a drag in the market for it to be worth while to adopt such measures, but there may be places where it is advisable to keep up pure, or nearly pure, bamboo forest for supply purposes, and perhaps cleanings and certainly annual thinnings will, I submit, prove useful with *Dendrocalamus strictus*, *Bambusa polymorpha* and even the "Wabo" *Dendrocalamus giganteus*. Again, in the forests of *Dendrocalamus Hamiltonii* in Northern Bengal and Assam, of which perhaps the ones I know best are those of the Kurseong Division in Bengal, annual thinnings, with the cleaning of dry and broken pieces, will probably be the best system of management. The species is, however, a poor one in strength and its habit of growth is very different to that of *Dendrocalamus strictus*, as the culms do not grow straight but curved and slanting and interlacing. In my opinion, wherever the forests are suited to it and the demand is sufficient, attempts should be made to replace it by planting *Bambusa Tulda*, *Bambusa Balroa*, or other similar valuable kinds. I mention this, as I held the same opinion strongly several years ago, when I was Conservator of Forests in Bengal.

J. S. GAMBLE.

*Memo. on thinning and cleaning of bamboo clumps in the Saharanpur
Division, School Circle, N.-W. P. and Oudh.*

Before the present Working Plan was enforced, the cleaning of bamboo clumps in the Ranipur and other blocks was done departmentally. In fact, contractors were employed to clean the congested clumps and thin out other clumps under departmental supervision. They were paid, not at daily rates of wages, but at fixed rates per score of marketable bamboos extracted, according to sizes, i. e., 10-ft. bamboos and *Bahis* at 2 annas per score, *Lathis* and *Punchis* at one anna per score, etc. This system was found defective, as the contractors were naturally inclined to pass over the congested clumps, the cleaning of which demanded most labour and from which a comparatively smaller quantity of marketable bamboos would be obtained. On the other hand, the contractors had a tendency to cut more bamboos than was desirable in the better clumps, simply to swell their wages without much labour. In 1895-96 I paid an extra rate of 3 to 6 pies per clump for those which were cleaned satisfactorily with a view to induce the contractors to do better work; but even this system was only partially successful. Besides, the difficulty of selling the bamboos obtained from the thinnings, with any profit or even at cost price, was great, and a large quantity deteriorated and had to be written off stock. A system of selling the bamboos direct to the contractors, who do the cleanings of the clumps, was, therefore, gradually introduced and this has been so far successful.

In 1896-97 the Working Plan was brought into force and since then the bamboo clumps have been operated on, by contract as a rule, with the following conditions:—

- (1) About one-third of the total number of culms are removed from the good clumps in such a manner that the remainder of the bamboos will stand apart from each other all over the clump.
- (2) No bamboo will be cut at more than 6 in. above ground.
- (3) As a rule, no bamboo less than a year old will be cut except where this is necessary for improvement of the growth.
- (4) The congested clumps will be cleaned without any regard to the number and kind of bamboos cut, but only with a view to open out the clumps, so that bamboos will remain standing all over the clumps at about 6 in. apart.
- (5) The contractor will prepare from the bamboos cut in the above manner marketable bamboos of all possible sizes, and will export them, after payment of a fixed rate of royalty, which is settled at the annual public auctions and noted below.
- (6) The contractor also pays a security deposit in cash, varying from Rs. 25 to Rs. 100, according to the size of the coupe in which he works, for the due fulfilment of the above conditions.

The above system has been found during the past three years to promise a practical and financial success. The contractors are bound down by formal agreement and security to thin and clean the bamboo clumps properly and to export all the marketable bamboos after paying a fixed royalty. Of course, we have special difficulties in one way. For instance, where the number of congested clumps is large, it is impossible to expect a contractor to clean all of them in one season, as

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he must make some profit. In some such instances I was obliged to make a condition that out of one hundred clumps from which the contractor cuts bamboos there must be at least 25 congested clumps which he must clean. At this rate the total number of congested clumps in that particular block will have been cleaned out in 4 years. Again, for instance, I think condition (1) will not perhaps hold good after the clumps have been improved by the annual thinnings; I think we are getting much more new growth now, and that we shall perhaps have to cut about half the number of culms in good clumps to keep them from getting congested.

The famine in the past two years hindered the progress of our bamboo work, as of all others, but there is no doubt that the present system is a good one. We are doing material improvement in our bamboo forests, not only without any cost whatever, but with the profit of all the royalty we obtain from the cleanings and thinnings. In 1897-98 we cleaned out 15,442 congested clumps without cost, and the revenue obtained from the operation was still Rs. 1,104.

The rates of royalty paid by contractors for bamboos exported from the thinnings, as referred to in condition (5) above, are as follows :—

Kind of bamboos.	Rate per score.					Standard for the Division.
	Ranipur.	Bám.	Chillawali.	Súkh.	Mohand and Khujawar.	
Sarauch 15 ft. long.	0 5 0	...	...	...	...	0 5 0
" 12 " "	0 3 0	0 1 6	0 2 3	0 2 3	0 2 3	0 5 0
Chaneju 10 " "	0 2 6	0 1 3	0 1 9	0 1 9	0 1 9	0 2 0
Bahi 7 " "	0 2 6	0 1 3	0 1 9	0 1 9	0 1 9	0 2 0
Charkalan 10 ft. "	0 2 6	0 1 3	0 1 9	0 1 9	0 1 9	0 2 0
Charkhurd 8 " "	0 1 3	0 0 6	0 0 9	0 0 9	0 0 9	0 1 0
Rakmi or Punchi } (top pieces) 10 ft. long	0 1 3	0 0 6	0 0 9	0 0 9	0 0 9	0 1 0
Lathi 6 ft. long ...	0 1 3	0 0 6	0 0 9	0 0 9	0 0 9	0 1 0
Paini or Kain 4 ft long.	0 0 6	...	...	0 0 3	0 0 3	0 1 0
						per head load.

The above statement shows that we are getting royalty, which is very nearly equal to the standard rates of the Division. In fact we are actually getting more in Ranipur owing to its proximity to the Jwalapur bamboo market,

K. N. MUKERJEE,

Extract (para. 100) from the Annual Administration Report of the Central Circle, N.-W. P. and Oudh, for the year 1895-96.

In the Ganges Division an experimental attempt was made at cleaning the bamboo clumps over a given area of forest, with the view of increasing the productive capacity of the clumps. When subjected to constant cutting the bamboo clumps get so choked with the dead stumps left from previous operations, that if the production and development of new stems is not hindered thereby, as would seem probable, the labour of getting at the latter is considerably increased. However, the experiment clearly showed that the expense and difficulty of control attaching to the operation are obstacles to its introduction into practical forestry. Moreover, the bamboos on an area thus cleaned might all flower and die within the next few months, thereby rendering useless all our labour and expense, and this possibility is of itself sufficient to condemn the practice of cleaning the clumps.

In the Conservator's opinion the most practical way of increasing the supply of bamboos will be to abolish the existing system under which each bamboo block is closed for one year before being cut over again.

The voluminous correspondence on the subject of bamboo production shows that even experts are unable to state positively that the annual cutting of the clumps is calculated to decrease production; in fact, common sense would seem to support an opposite conclusion, when it is considered that the order of plants to which the bamboo belongs is peculiar for the property possessed by them of multiplying the number of their stems and the vigour of their growth in proportion to the cutting back to which they are subjected. We see instances of it in our grasses which flourish and extend laterally in proportion to the degree of surface cutting applied to them. To open the entire bamboo area to annual cuttings would, in the Conservator's opinion, *just double the outturn* from this source, and the subject is consequently one deserving the most serious attention. If the people do not require so large a quantity of bamboos, they will at least, under this change of system, get them cheaper.

Note on Improvement fellings for the benefit of Teak in fire-protected Reserved Forests, Burma.

In 1870 a formal declaration of the forest policy for the future working of the forests in British Burma was made by the Chief Commissioner in his Resolution on the Forest Administration Report for 1869-70 (paragraph 20 of Public Works Department letter No. 426-48F., dated the 6th August 1870). The policy was laid down on two lines merely, the second of which was :—

"To look to plantations as the future main source of our timber requirements."

In their review of the above the Government of India (Public Works Department No. 620F., dated the 15th October 1870, paragraph 19) endorsed this policy and expressed its scope more definitely, as under—

"The general duties of the Department for the present may briefly be stated as follows :—

- (1) The extension of teak plantations on a large scale in a few well selected blocks.*
- (2) The demarcation of the most valuable forest tracts as State forests.*
- (3) Meanwhile, careful husbanding of the resources of the existing forests."*

2. During the 28 years that have elapsed since then, vast changes have taken place both as to the extent and as to

the constitution of the teak-producing areas entrusted to the management and control of the Forest Department in Burma.

When the above forest policy was defined, it seemed not improbable that the civil divisions of Pegu and Tenasserim would have to be considered the main sources, from which the world's future supply of teak timber would have to be drawn, and measures had to be considered for ensuring in the future the maintenance of a sustained yield of marketable teak timber.

Now, however, we have not only a well organized system of management, prescribed by working-plans, either already sanctioned or else shortly to be prepared for sanction, in force throughout the principal teak forests in Lower Burma, but we have also the control and a fairly good knowledge of the vast teak-producing tracts spreading over enormous areas in Upper Burma and the Shan States. The Government of Burma have now under their control huge areas, which certainly equal and probably far excel, the forests of Lower Burma in the quantity of first class marketable teak which they are capable of supplying, *in perpetuo*, under competent management.

3. With such sources of supply now at command it is no longer necessary "*to look to plantations as the future main source of our timber requirements.*" So much so is this the case that the time has now come for asking whether it may not be advisable to curtail teak plantation work, so far as is practicable, and to invest the money thus made available for the carrying out of improvement fellings for the benefit and development of the existing stock of immature teak, whether trees, poles, saplings or seedlings, usually to be found in greater or less abundance throughout all teak-producing areas.

4. Where teak is not now found as a constituent among the trees of any forest, or is only sparsely represented, it stands to reason that it can only be introduced artificially by means of sowing or planting. Apart from exceptional cases, such as relate to agreements or questions of policy with regard to Karen or Kachin tribes and the like, where the Forest Department is, or may be committed, to forming plantations in order to secure the good will of such hill tribes, or to carry out agreements made at the time of forest settlement of reserves, there has been throughout the last ten years a strong and an ever-strengthening opinion that plantation operations should be curtailed, and that more attention and money should be devoted to improvement fellings. In teak-producing areas it is seldom that *taungya* tracts can be selected so as to include no teak, and in some instances the damage done to the existing stock of teak and of cutch is sufficient to stamp the formation of plantations in such localities as unnecessary and wasteful. In proof of this, attention may be called to recent reserve inspection notes.

5. When teak plantations were originally started it was hoped that after about two years' weeding and cleaning they might be trusted to outgrow danger from lofty grasses, creepers, softwoods, &c. Experience has shown that such is not the case. It is only in very exceptional cases that plantations can be left unweeded in their third year, and sometimes the operation has to be repeated during the fourth year. Even then weeding and cleaning have to take place at intervals for several years more; and such weeding and cleaning operations are hardly or even not yet completed when one finds one's self face to face with the necessity for thinning. Thus, in 1896, I found myself compelled, as Conservator of the Pegu Circle, to have plans of thinning operations drawn up for plantations in the Tharrawaddy and Rangoon Divisions though funds were scarce.

The plantations in some of the divisions of Lower Burma are already so extensive as to seriously interfere with the other work of the Divisional Officers.

6. That areas suitable for improvement fellings abound in our reserves in Upper Burma can be proved by reference to the following portions of reserve inspection notes:—

Pyinmana Division Inspection Notes, 1896-97.

Natural regeneration of teak is on the whole very satisfactory considering the excessive extent to which the forests have been depleted of all mature marketable trees. But, owing to jungle fires, there is a striking paucity of *pyingado* seedlings notwithstanding the abundance of large and well-grown mature trees. Young teak trees and poles are frequent, and in many places seedlings are abundant, though at present burned back year after year by the jungle fires and overshadowed by the bamboo undergrowth (mostly *kyathaung*). Under such circumstances, it seems to me that *improvement fellings* in selected and carefully fire-protected areas are the soundest, most advantageous, and most economical method of improving the future teak-producing capacity of the forests.

Notwithstanding the satisfactory nature of operations in those teak *taungya*, I am not in favour of extending them or of committing ourselves to the formation of plantations; for *natural regeneration* of teak is on the whole decidedly good throughout those parts of the reserve traversed, remarkably so, considering the treatment these forests have received during the last 30 years. Hence it seems to me better policy and more economical investment of money to make *improvement fellings* in selected areas to be carefully fire-protected for several years, i.e., which shall receive *special protection* in addition to any general fire-protective operations applied to the whole reserve or to large portions of it.

With the establishment now at our command, or with any increase likely to be obtained within the next year or two, we cannot afford to commit ourselves to plantations and at the same time hope to carry on improvement fellings successfully on any large and systematic scale; and of the two alternatives I think the improvement fellings deserve the preference considering the general satisfactory state of natural regeneration of teak.

In the revised plan of operations for 1896-97 proposals have been made for the formation of 100 acres of teak plantations. I am most decidedly of opinion that no further plantation work should be carried out here unless privilege-holders claim to clear *taungya* lands and plant them up with teak; and in this case they should only be allowed to clear *ya* in

such portions of the reserve as bear no stock of teak, as, for example, in some of the old bamboo *pônzo* near the northern end of the reserve. There are so many places in the Pyinmana block of reserves where *natural regeneration* of teak is very good, and where improvement fellings will yield far better and more remunerative results, that I consider the fire-protection and improvement of such selected areas a much preferable work to committing ourselves to *taungya* plantations with the toilsome years of weeding and cleaning, which are hardly completed before the necessity for thinning stares one in the face.

Cessation of planting.—I am most distinctly averse to the formation of any more plantations in this reserve. We have got rid of the privilege-holders who could claim to cut *taungya*, and *natural regeneration* of teak and of *pyingado* is already so good that nothing further is required than a continuation of the present successful *fire-protection* in order to permit seedlings to establish themselves. The Ranger states that, except in the *indaing* portions, it would be almost impossible to pick out blocks for planting which do not already contain at least 15 trees, poles are saplings per acre, not to mention seedlings; and his statement seems to be fairly borne out by the observations made during the present tour of inspection. In the 1896 plantations, 46 large logs of green teak have been extracted by the Bombay-Burma Trading Corporation, Limited, while numerous large teak trees and many poles have been killed or else damaged so badly as to be hopelessly disabled from ever developing into sound marketable trees.

Katha Division (Mohnyin Reserve) Inspection Notes, 1897.

Teak taungya plantations have not yet been begun, and there seems no necessity for making any commencement with them. Though *natural regeneration* of teak is at present extremely poor in the vicinity of Kadu, yet in the southern portion of the reserve drained by the feeder of the Ledan *chaung* it is particularly good throughout the areas in which *tinwa* forms the chief and characteristic undergrowth. Here *natural regeneration* in family groups is decidedly good, and though the experiment of annually cutting out the *wanu* or soft shoots from the bamboo clump has not (as anticipated) resulted in any decrease of the amount of over-head shade, or in any diminution in the reproductive power of the bamboos, yet the clearance of all shoots in places where teak seedlings have been found has resulted in a very vigorous development of the latter. This method of treatment referred to in paragraph 50 of the working plan as *experimental operations for the reproduction of teak in the bamboo forest* should be carried on as extensively as the means at the Divisional Officer's disposal permit, for the formation of compact family groups of teak in this manner is probably the best of all means of regenerating this species. Moreover, the local climate and the characteristic vegetation of this reserve enable such operations to be conducted with a far freer hand than would be judicious in teak tracts in Lower Burma, where the *kyathaung* bamboo forms the main undergrowth. Cultural measures of this nature are easier to carry out, cost less, and entail fewer subsequent operations as to weeding and cleaning than teak *taungya*; hence it is better to expend on the former all the money and supervision at disposal than to sink these in plantations that will demand annually recurring attention as regards weeding, &c.

This, of course, by no means precludes full advantage being taken of exceptionally favourable opportunities for *natural regeneration* on a larger scale. Whenever bamboos flower sporadically or gregariously over reserved tracts, such tracts should be specially fire-traced, burned over whenever the bamboo seed falls, and sown or dibbled with teak. So far, however, as it lies in his power, the Divisional Officer should utilize the opportunities for *natural regeneration* offered by the removal of bamboos from patches showing a stock of teak seedlings and, if a well-considered plan can be forecast for thus treating portions of the reserve systematically year by year, this will be far more advantageous than operations of a less regular and defined nature. When all such areas have been operated on, it will be time enough to consider the planting up of the *pônzo* along the western boundary of the reserve.

as prescribed in paragraph 50 of the working plan. In the meantime money and supervision can be more profitably invested in cultural operations of the above nature.

Katha Division Inspection Notes, 1898.

6. *Natural regeneration* is on the whole decidedly good. In the southern reserves (Pilé, Tatlwín, Pyindé, Nankan) and in Nami it is in many parts so satisfactory that this, assisted by fire-protection and by improvement fellings, should quite suffice for ample supplies of teak in the future. Near the Shimpá teak *taungya* in the Nankan reserve, natural regeneration of teak is perhaps richer than in any other place I have ever seen. It is excellent, the various girth-classes being represented. Under such circumstances teak *taungya* are quite uncalled for. Further remarks relating to this subject will be found below under 9—*Plantations*; but the following diary extract relative to the *Nami* reserve may here be quoted as illustrating the local conditions of the reserves:—

"In the evening went due east into the Nami reserve for about a mile-and-a-quarter. It closely resembles in character the reserves in the south of the division (Pilé, Pyindé, Nankan) in having apparently no marketable teak trees left standing, in having been fearfully hacked about by village girdlers, everything down to young trees and even poles having been killed, and in having a wonderful regenerative power. In many parts the ground is covered with seedlings, or rather with coppice-shoots, beside which the blackened, burnt shoot of 1896 stands or lies. As in the other reserves, no plantations are required here; fire-protection and improvement fellings are all that are essential, and would at the same time form a far more remunerative investment than plantations. The Nami *chaung* is a first-class floating stream."

8. *Climber-cutting, figs-cutting, and improvement fellings*, are—solely owing to want of trained supervision—unfortunately at present confined to the Pilé and Mohnyín reserves. As sowing and planting operations are really unnecessary in view of the fine natural regeneration of teak obtaining in many of the reserves, operations of the nature of improvement fellings seem the most remunerative and promising means of obtaining the best and most valuable future supplies of teak. The cheapest and most practical way of furthering this object is at present under the Conservator's consideration, and explicit instructions on the subject will issue before next working season. At present the creeper-cutting and the felling of stems covered with epiphytic *figs* is carried out by the ranger or forester a year in advance of the improvement felling, the latter being undertaken by the Extra Assistant Conservator of Forests in Pilé reserve and by the Divisional Officer, Mohnyín. Under such circumstances the rate of progress is obviously far behind what is desirable, as only comparatively small areas can be dealt with annually.

Ruby Mines Division Inspection Notes, 1898.

Natural regeneration is on the whole fairly good. In some parts, particularly throughout the northern portion of the block of reserves, the regeneration by means of family groups of teak is excellent, all age classes being duly represented. All that is wanted for the development of the teak in such localities is fire-protection and improvement fellings.

Such conditions are not merely characteristic of the Eastern Circle of Upper Burma teak forests alone. They likewise obtain with regard to the majority of the teak-producing tracts which form the reserved forests throughout the Pegu and Tenasserim Circles (Lower Burma), and I am informed that similar conditions are also found throughout the chief teak-producing (reserved) areas in the Western Circle (Upper Burma).

7. It will be seen from the above extracts that such *improvement fellings* are only intended to be carried out in fire-protected areas. This is a *sine qua non*, and the whole of the suggestions contained in this note are based on the understanding that such improvement operations shall, of course, take place only in areas protected against fire.

8. Unless artificially assisted in its struggle for existence with the various other kinds of forest trees, &c., many of which are of more rapid growth than teak, it must naturally follow that a larger outturn in teak and a higher financial return from the reserved forests can only be expected in proportion to the expenditure incurred, under competent supervision, in assisting the teak in its struggle for existence, in shortening the duration of such struggle, and in obtaining for teak special advantages for growth and development by the felling or girdling of trees which strangle it (*Ficus*), or dominate, or otherwise interfere with its crown of foliage and its free exposure to light and air. For such *improvement fellings* money and trained supervision are essential. Moreover, this is not an operation which can be done once for good and all. It will have to be repeated from time to time, at intervals which should not exceed ten years, if this can be rendered possible with the means at our command.

9. The total area of reserved forests in Burma now amounts to some 15,000 square miles, and before the selection of State reserves is completed, it will probably amount to over 20,000 square miles. Of this it may be estimated that not less than the half, or 10,000 square miles, will be teak-producing tracts which should be gone over by *improvement fellings* at intervals not exceeding ten years. This will give an area of 1,000 square miles per annum to be operated over, or 640,000 acres annually. Even, however, presuming that this estimate may perhaps be far in excess of the area that really deserves and requires to be operated over, or that can be fire-protected and rendered suitable for improvement fellings, then let it be drastically reduced by 50 per cent., and there still remain 500 square miles, or 320,000 acres to be gone over annually, if we are to accord to the teak forests the treatment essential towards providing anything like the outturn in timber and money which the State may derive under proper management of their very valuable forest properties.

10. But we have at present no staff of provincial officers or of trained subordinates such as is necessary to operate properly over even a tithe of so extensive an annual area as 320,000 acres. Past experience in different parts of Burma has shown that operations like *improvement fellings*, which require circumspection and a certain amount of judgment, cannot be entrusted to untrained rangers. Such operations have, in some cases, proved not merely a waste of money, but have

actually been productive of positive harm, in place of bringing benefit to the existing stock of young teak.

11. Such untrained rangers can only be trusted to fell all trees (whether teak or not) in the bonds of epiphytic *Ficus*, and to cut woody climbers; and these are preliminary operations which should take place during the working season before that during which improvement fellings take place. When this preliminary step has once been taken, there still remains for consideration how, and to what extent, trees interfering with the growth of teak should be removed. Leaving bamboos and other lofty grasses out of consideration, the trees that it may be desirable to deal with for the benefit of the teak trees, poles or seedlings, may belong to one or other of the following three classes:—

- I.—*True heart-wood trees*, which die on being girdled.
- II.—*Sap-wood trees*, whose vegetative processes do not appear to be interfered with by girdling.
- III.—*False heart-wood trees*, which sicken or are distinctly interfered with, temporarily, in growth by girdling, but are not killed by the operation.

This last or intermediate class consists of kinds of trees which might perhaps in many instances be killed off by a second girdling, if it were practicable to go over the area again and re-girdle in the following year.

The I class (*true heart-wood trees*) comprise the more valuable kinds of timber trees like teak itself, cutch (*Acacia catechu*), padauk (*Pterocarpus indicus*), pyingado (*Xylia dolabriformis*), ingyin (*Pentacme Siamensis*) and also such trees as the following:—

Taukkyan (<i>Terminalia species</i>).	Petthan (<i>Heterophragma adenophylla</i>).
Thitpyu (<i>Xanthophyllum species</i>).	Naywè (<i>Flacourtia species</i>).
Thadi (<i>Bursera serrata</i>).	Thitpagan (<i>Millettia species</i>).
Thitya (<i>Shorea obtusa</i>).	Seikche (<i>Bridelia retusa</i>).
Thitsi (<i>Melanorrhæa usitata</i>).	Petwôn (<i>Berrya amonillis</i>).
Thahye (<i>Eugenia species</i>).	Binga (<i>Nauclea rotundifolia</i>).
Ngu (<i>Cassia fistula</i>).	Thande (<i>Stereospermum neuranthum</i>).
Tè (<i>Diospyros Burmanica</i>).	Sit (<i>Albizia procera</i>).
Kokko (<i>Albizia Lebbek</i>).	
Yamane (<i>Gmelina arborea</i>).	
Mahlwa (<i>Spathodea stipulata</i>).	

The II Class (*sap-wood trees*) includes the following among many others:—

Thabutgyi (<i>Miliusa velutina</i>).	Baing (<i>Tetrameles species</i>).
In (<i>Dipterocarpus tuberculatus</i>).	Thitè (<i>Castamopsis species</i>).
Kanyin, (<i>Dipterocarpus species</i>).	Myauklôk (<i>Artocarpus Lakoocha</i>).
Thipwe (<i>Elæocarpus bracteatus</i>).	Myauknyo (<i>Duabanga sonneratioides</i>).
Yôn (<i>Anogeissus acuminata</i>).	Kathit (<i>Erythrina species</i>).
Thitsein (<i>Terminalia Belerica</i>).	
Zibyu (<i>Cicca Macrocarpa</i>).	

Letpan, Didôk, Kokbê, (<i>Bombax species</i>).	Thayet (<i>Mangifera indica</i>).
Myaukchaw (<i>Homalium tomentosum</i>).	Thitni (<i>Amoora Rohituka</i>).
Thapan (<i>Ficus glomerata</i>).	Thanthat (<i>Albizia lucida</i>).
Gwe (<i>Spondias mangifera</i>).	Pauk (<i>Butea frondosa</i>).
Gyo (<i>Schleichera trijuga</i>).	Bambwê (<i>Careya arborea</i>).
Nabe (<i>Odina Wodier</i>).	Ondôn (<i>Tetranthera laurifolia</i>).
Chinyôk (<i>Garuga pinnata</i>).	Zinbyun (<i>Dillenia pentagyna</i>).
Ma-u (<i>Sarcocephalus species</i>).	Zaungbalwe (<i>Genus unknown</i>).
Nagyê (<i>Pterospermum semisagittatum</i>).	Shaw (<i>Sterculia species</i>).
	Myanhôkshit (<i>Siphonodon celastrinus</i>).

The III Class (false heart-wood trees) contains such trees as—

Thitlinda (<i>Heterophragma sulfurea</i>).	Madama (<i>Dalbergia species</i>).
Bônmeza (<i>Albizia stipulata</i>).	Tauksha or Kyetyo (<i>Vitex leucoxylon</i>).
Thitpôk (<i>Tetrameles nudiflora</i>).	Thitmagyi (<i>Albizia odoratissima</i>).
Lêza (<i>Lagerstrœmia tomentosa</i>).	Kuthau (<i>Hymenodictyon thrysiflorum</i>).
Yingat (<i>Gardenia species</i>).	Lettôkgyi, Lettôkthein (<i>Holarthrena species</i>).
Bebya (<i>Cratoxylon neriifolium</i>).	Pyinma or Tikhmwe (<i>Lagerstrœmia flos reginæ</i>).
Hnaw (<i>Nauclea cordifolia</i>).	
Ondôn (<i>Tetranthera laurifolia</i>).	
Kyunbo (<i>Premna tomentosa</i>).	
Yindaik (<i>Dalbergia cultrata</i>).	
	Panga (<i>Terminalia tomentella</i>).

The above classification must not be taken as hard and fast, for it is based only on the local observations made during one working season in the Pyinmana and Katha Divisions. A comparison of further and more comprehensive observations is therefore requisite, more especially with regard to many of the trees arranged above in the II and III classes. This enumeration of trees either unaffected or else only partially affected by girdling, however, extends to some fifty trees commonly to be found associated with teak in teak-producing areas. Experimental improvement fellings carried out in the Yanaungmyin reserve (Pyinmana Division) during June 1897 showed as their result that not only 42 per cent. of the trees girdled survived the operation, although the girdle was deep and broad, but also that in November, five months later, in many cases no material reduction was noticeable in the density of their foliage, and in that of the shadow cast by them on the underwood. This fact is one which demands very careful consideration, as it really forms the *crux* of the whole matter at issue.

12. As regards the trees of the I class, which die when girdled, the girdling operations can be performed by coolies working under the supervision of any subordinate. But what cannot be safely entrusted to untrained rangers is the selection of trees to be removed. In such cases it has only too often

happened that large trees have been girdled for the sake of very small seedlings. Hence the result has often been to benefit other species of trees or bamboos far more than the young teak. Besides this, inspection has shown that untrained rangers seem to lose all sense of proportion between the cost of girdling a large tree on the one hand, and the prospective benefit to be gained in affording special protection to a very small seedling or a badly-grown pole. To train special men as *gaungs* (on about Rs. 40 to Rs. 50 per mensem) for such improvement girdlings should, however, be a simple matter. It should not be more difficult than to train enumerators for valuation surveys in connection with the formation of working plans.

13. With regard to trees of the II and III classes, it appears very questionable whether it would be safe to entrust such operations to any but trained rangers or Extra Assistant Conservators of Forests. The experiment might perhaps be tried to employ specially trained *gaungs* on such work. In fact, it can only be by adopting some such plan that any real effort can possibly be made to cope with the enormous annual areas, which must be gone over, if the Forest Department is to be expected to adequately improve (in teak-producing capacity) the areas entrusted to their care on behalf of the State.

But such *gaungs* can, under no circumstances, be allowed to undertake operations except under the direct supervision of a competent trained ranger or an Extra Assistant Conservator of Forests or Assistant Conservator of Forests. An experiment is now being made in each of the divisions of this circle to see if sap-wood trees and false heart-wood trees can be killed by means of corrosive sublimate inserted into them for the purpose of poisoning their sap. If it should prove successful, then this mode of gradually killing them may, perhaps, be found capable of application on a large scale. But in any case trained supervision will be necessary to direct and control the killing of the trees so as to ensure that their removal will not be in reality more beneficial to useless trees, bamboos, &c., than to the teak it is intended to benefit.

14. Recent experiments in the Katha and Pyinmana Divisions show that an Extra Assistant Conservator of Forests or trained ranger can direct and control the work of about 15 to 20 coolies, and can operate over about 300 to 350 acres per mensem. They have also shown that the cost of such operations, exclusive of the salary and travelling allowance of such officer, amounts on the average to about Rs. 1-8-0 per acre for the cutting of woody climbers, the felling of trees attacked by epiphytic *Ficus*, the girdling of heart-wood trees, and the felling of sap-wood trees overshadowing or interfering with the growth and development of teak.

15. Now, it is obvious that at the above rate we cannot hope to accomplish anything like the task of carrying out

improvement fellings over the whole of the teak-producing areas once every ten years. There seems no way of avoiding or obviating the conclusion that the rate of progress under trained rangers or Extra Assistant Conservators of Forests is much too slow to satisfy our requirements. To accomplish the task lying before us—a work of immense economic and financial importance as regards the stock of marketable teak timber a hundred years hence—it seems essential that we should give special training to a number of selected men to act as *gaungs* or overseers (on Rs. 40 to Rs. 50 per mensem), and that each *improvement-felling party* should consist of an Extra Assistant Conservator of Forests or a trained ranger controlling and supervising the work of five such *gaungs*, each working with 15 coolies a day. Such a party would proceed to the area to be operated over, where the Extra Assistant Conservator of Forests or trained ranger in charge would occupy a central camp, the *gaungs* or overseers being distributed round about in their own camps within a mile or two of the central camp. From the latter the Extra Assistant Conservator of Forests or ranger in charge could conveniently supervise the work of each of the various sub-parties at least once a week. As soon as the operations in one portion of the forest were completed the whole party could move on to another portion and continue operations there.

Even with such control and supervision there would always be a risk of the Burman *gaung* or overseer acting injudiciously with regard to the felling of sap-wood trees and those having a false heart-wood (classes II and III, as above). But, with the supervision of a competent officer, exercised at least once a week, this risk seems preferable to having the work of improvement fellings done practically only in dribblets, leaving vast areas unoperated over. A definite plan based on fire-protection operations extending to a fixed area, and carried out in a prescribed sequence, is essential to the proper execution of such work.

10. The average cost of each such improvement-felling party would be as follows:—

I.—*Each sub-party*—

	Rs.
One <i>gaung</i> or overseer at Rs. 45 per mensem	45
Fifteen coolies at 10 annas per diem, say	255
Total per mensem	300

II.—*Full party*—

Consisting of five such sub-parties, per mensem	1,500
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Each sub-party ought to be able to accomplish the whole of the work of creeper-cutting, *Ficus* felling, and girdling or felling inferior species interfering with teak over at least 200 acres per mensem, or 1,000 acres per mensem for the full party, at a cost of Rs. 1,500, or Rs. 1-8-0 per acre. The better parties might accomplish work over 800 acres per mensem, but it seems

preferable to adopt the lower number as the minimum unit of area which should be operated over by a sub-party. Each party should be able to work for three months; hence the total area operated over should, therefore, not be less than 3,000 acres per annum, costing Rs. 4,500. Most likely this total area might be increased as the men acquired skill at the work, the total cost remaining the same, but the rate per acre becoming diminished; consequently it may perhaps be safe to put the three months' or season's work of one such party at 5 square miles (3,200 acres). It would, therefore, require 100 such parties and an outlay of Rs. 4,50,000 per annum to accomplish the full amount of work necessary in the future interests of the teak forests throughout Burma, as referred to in paragraph 8 above.

17. With the very limited number of trained rangers, Extra Assistant Conservators of Forests, and Assistant Conservators of Forests at disposal, it will of course not be practicable (quite out of the question, in fact) to dream of conducting operations for very many years to come on anything like so complete or extensive a scale. But I think the subject is, at any rate, of such importance that it should be referred (in the absence of any professional Head of the Department in Burma) to the Inspector-General of Forests, now in this province, to advise the Local Government—

- (1) as to the extent to which such improvement fellings should be made in each of the four circles;
- (2) as to the extent to which operations should be conducted with regard to sap-wood trees and false heart-wood trees which do not die after being girdled;
- (3) as to the sequence in which the operations should be carried out;
- (4) as to the agency to be employed, i.e., whether the Extra Assistant Conservator of Forests or ranger is to operate directly with coolies or to supervise the operations of sub-parties in charge of *gaungs* or overseers; and
- (5) as to the time of the year during which the operations should be carried out.

He will thus have an opportunity of contributing towards the solution of one of the most difficult, and one of the most important problems, which the Forest Department in Burma has now to consider. Mr. Ribbentrop's remarks in paragraph 3 of his letter No. 25 W.P., dated the 24th January 1898 (copy of which was forwarded under cover of your Forest Department letter No. 75-1W.—4, dated the 4th February 1898, and an extract of which is hereto appended for ready reference), are most unquestionably correct; but they neither recognize nor provide for the necessity of having, first of all, a full, free and critical discussion of the various points requiring consideration; and secondly, having well-considered proposals prepared and

placed before the local Government for definite orders as to the line of action to be taken in carrying out this important work throughout the whole of Burma. No reserve is homogeneous in character as to growing stock and physical factors. In no division are all the reserves similar in character. And in no circle are the circumstances of the different divisions and reserves anything like similar. But the main principles ought obviously to be laid down for general application as to the manner in which the work should be taken in hand; and Mr. Ribbentrop's visit to Burma seems a very favourable opportunity for obtaining a definite opinion from the Head of the Forest Department on the subject which may be acted on consistently throughout the four circles in the immediate future.

18. There is also another very important matter which should at the same time be considered, and consideration can hardly be suitably given to it unless in connection with a scheme for improvement fellings. I refer to the flowering, seeding, and dying off of the *Kyathaung* bamboo, which may now happen in any year, and must occur soon, over enormous tracts of teak forest on both sides of the Pegu Yoma. This will be a sylvicultural opportunity such as has never previously occurred in Burma. Simultaneously with the use of fire (under due control) as a destructive agent for killing the germinative power of the bamboo seed, improvement fellings, sowings, dibblings, &c., will have to take place, on the largest possible scale, capable of being adequately controlled and carried out.

As it is well known that the *Kyathaung* areas will require such special treatment at some early date, it may perhaps be preferable not to include them at present in the instructions which may be issued by the local Government with regard to improvement fellings in other teak-producing areas. But in any case, I would recommend that the Inspector-General of Forests, in the absence of other professional Head of the Forest Department in Burma, be invited to formulate a definite plan of action for the treatment of the *Kyathaung* tracts before the general flowering takes place shortly. Unless such definite plan of operations be discussed and decided on beforehand, the flowering will find the Forest Department without any well-considered line of action ready for adoption. It is impossible that, with the means now at disposal, anything like a quarter of the area can be subjected to the cultural measures and improvement operations that will be desirable for future financial reasons.

19. Special consideration will have to be given to the time of the year at which improvement-felling operations should be carried out. I consider that the best time is to commence operations immediately after the first showers of rain have fallen, and the main danger from fire is past. This would mean conducting them from the second half of April till the second half of July. With good bamboo *tès* or huts for all engaged in the

work, this season of the year is less trying and less unhealthy than work which would extend into the hot season. Coolies object to hard work at the hottest time of the year, but they do not mind working in the rains so long as their hair is protected from getting wet. At such time of the year the intelligent class of working-plans enumerators would probably be willing to continue in service as *gaungs* or overseers in charge of sub-parties. If the work be carried out during the months of December to February, then this also means that the Extra Assistant Conservator of Forests or ranger cannot carry out other important duties, which can only be done at such season; and it also vastly increases the danger from fire owing to the extra mass of highly inflammable matter thus caused to litter the ground. As improvement fellings will only be carried out in fire-protected portions of reserves, this is a matter of considerable importance. Moreover, in most localities, the requisite supply of labour is much more difficult to obtain in December to February than from the end of April to July.

J. NISBET,

Offg. Con. of Forests, Eastern Circle.

Extract of letter from the Inspector-General of Forests to the Revenue Secretary to the Government of Burma,—No. 25 W. P., dated the 24th January 1893.

3. With regard to paragraph 51, I think that more definite prescriptions should be laid down in the (Yeni) working plan regarding the proper execution of the improvement fellings. These are of the greatest importance as regards the future constitution of the forests, particularly as fire-protection favours the growth and reproduction of softwoods to a greater extent even than it favours teak; and the execution of such an important operation should not, I think, be left too much to the discretion of the Divisional Officer.

Surveying Instruments. *

By Thiéry.

Monsieur Thiéry, Professor at the National Forest School, Nancy, has recently published a book on surveying instruments, which can be very strongly recommended both to the student and those engaged in the practical work of surveying. It has been thoughtfully written and carefully arranged.

Each detail in the construction of the different instruments and the methods of use are elaborately and systematically explained.

* Des Instruments topographiques, description, réglage et méthodes d'observation. Par E. Thiéry, Nancy, Imprimerie Nancéienne, 1889.

The chapters relating to Levels and Theodolites; and their use in the measurement of heights, distances, and angles are particularly clear; and the illustrations, showing details of construction are practically well drawn and explanatory. The same commendation applies to all the diagrams.

The chapter on the Tracheometer is very good, and fully explains how this useful instrument is constructed and worked.

To give any idea of each instrument embraced in this work would mean a very lengthy article. It is sufficient to say that in it all the instruments in ordinary use, their errors, adjustments, and methods of manipulation, are most lucidly explained and illustrated.

Some experiences with Panthers.

The want of Shikar stories in our magazine is so often brought up as a slur on our department, that I venture to send a short account of some experiences with panthers which seem to be somewhat out of the common.

That Panthers climb trees with the greatest facility is of course well known, but it may not be every one's luck to come upon them "up a tree," more especially as the extended view which they naturally enjoy in such a position, renders it, unless under exceptional circumstances, more difficult than ever to approach anywhere near them.

On the 15th April, one year, when I was posted in a Division somewhat near the centre of the Deccan, it happened that I awoke to find that it had been pouring with rain all night. The forests in which I was encamped at the time were teak forests, and everyone knows how useless it is to go for a stalk in such in the hot weather. Such a boon, therefore, as a heavy fall of rain, so uncommon at such a time, decided me to make the best of the opportunity and indulge in a stalk after bison, which, to my mind, is one of the most exciting kinds of Indian sport. I accordingly started at early dawn with a trusty Gond tracker. Before we had gone a mile, we heard the curious cry of what seemed to be a wounded animal. I thought it was a tiger and my thoughts flew at once to a tiger I had wounded two days before about three miles away—but that is another story.

My tracker, Tipo, said he was sure it was a big boar, so we approached in its direction, as silently as we could, hearing no more cries but instead we clearly heard the curious "koh-koh" of some wild dogs. As we got nearer we caught glimpses of wild dogs' heads as they jumped in the grass, which was about 4 feet high, but we could see no animal.

After a short time, however, we saw, crouched along a fairly erect branch of a *Saj* (*Terminalia tomentosa*) a panther, who was

so intent on watching the dogs below that he never saw us. Wishing above all things to pay off some long-standing grudges against wild dogs, which not only were causing fearful havoc among the game, but which were in the habit of taking a heavy toll from the buffalo calves whenever tied out for tiger, I tried to get a shot at them but could not, as we only saw their heads when they jumped in the grass around the trunk of the tree. I was then mean enough to take the poor panther at a disadvantage, and a shot behind the shoulder brought him plump to the ground. Nothing more was seen of the dogs which disappeared in the grass. I shall never forget the curious sight of the panther falling for those 50 feet through the air. We measured the distance we were from the tree and found it was 37 yards.

The panther was a male, 6ft. 1in. in length. The dogs must, I should think, have been very hard pressed to have attacked the panther, but that they had done so was evident and he had been driven to take refuge in the tree. In this he could only have been just in time, as his right fore-arm was found to have a great fresh gash in it, where a dog's tooth must have scratched him when beginning to climb the tree.

A brother forest officer informs me that he has come across a case of wild dogs not only attacking a panther but killing it. He was encamped near a village in an adjoining district to the one in which the incident just related occurred. The village was in a neighbourhood which was troubled with a man-eating panther which often made its headquarters in some low hills near the village. L—went out for a morning stalk, and being attracted to a certain spot in the forest by a frightful bullaballoo, spotted some wild dogs, of which he bagged two and found they had just killed a panther and were eating him. I saw the old tattered skin, which was one of L—'s great treasures. The panther turned out, too, to be the man-eater, at any rate from that date on, the surrounding country was bothered by him no more.

Another curious case of a panther found "up a tree" occurred in one of the Easternmost districts of the N.-W. P. The forest was a dense growth of *Sál* poles. A certain plot was taken in hand for coppicing and the coolies discovered in a very acutely forked *Sál* tree the skeleton of a panther, some 15 feet from the ground. The only explanation possible seemed to be that the beast had climbed up there during a beat held by some people from the headquarter's station some time previous, and had got wedged in, and the more it struggled the tighter it became fixed.

The most unfortunate experience I have ever had, however, occurred with a panther this last winter. It is one thing to shoot large game in the plains when, even if one is on the ground, one has a firm footing, but it is quite another to shoot the same animals on the steep rocky hills of the Himalayas where, if one is a plains-man one can often hardly

stand firmly at all. I was then in a valley among the mountains behind the first ridge of snow. I had been out in the forest all day on the 7th February 1899, and was having tea on my return at about 4, my boots having been discarded for slippers. One of my servants came running in to say that he had seen two shepherds driving a panther down the hill-side, some half mile down the river. I snatched up my Express and ran down the narrow foot-path, more sheep track than anything else, along the northern bank, thinking it was very possible that I should have a view of the brute, if he was really being chased towards the river.

As I reached a certain *khud*, I saw an old shepherd on the opposite side who told me the panther was coming. I had just time to climb up the steep slope a few yards above the path when the panther came galloping along with a sheep dog at his heels. As he passed below I gave him the first barrel and knocked him off the path, giving him the second as he disappeared round a rock forming the end of a precipice, covered with *Euphorbia* and scrub growth, overhanging the river, which was some 60 or 70 feet below. I certainly ought to have killed the beast outright at such close quarters, and could not have failed to do so had I had a firm footing; while as it was, what with the steep slope and what with my slippers, I had the greatest difficulty in standing up. At the first shot the dog turned round and disappeared from the scene being as startled as the panther was. We then moved above the precipice and tried to dislodge the panther; after heaving rocks for 5 minutes or more, we overbalanced a huge rock on the edge and I caught a glimpse of the panther's coat and fired vertically down at it, causing him to drop almost into the river, as he only just saved himself in some scrub above high flood level.

In this scrub he crouched out of sight once more. A shepherd, some 50 yards lower down the river said he thought he could see him and so I went round to where he was, but I could see no panther. However, the man declared he was beneath a certain shrub and as all the rocks the men continued to heave from above failed to move him and it was beginning to get dusk, I sent a bullet into the shrub hoping to move him, but it had no effect.

Meanwhile the shepherd had climbed a tree behind me and below me. The tree was a *siris* (*Albizzia Lebbek*) growing just above flood level, very branching and with an almost horizontal trunk. The upper branches were in my sight, and I had no idea either that the man was climbing up it, or that the trunk was such as it was. After my shot into the bush I was directing the men above the precipice to throw down more rocks, when out the panther bounded towards me but still some 20 feet or so below. Apparently the panther had seen the man climb the tree and was making for him in my right rear. I gave him another shot and he disappeared between the rocky

bank I was on and the river. I had just re-loaded my ejector when I saw the panther climb into my line of sight on the *siris* tree, and above him there was the shepherd. I blew the beast out of the tree and he fell out of my sight 40 feet clear on to the rocks below, and immediately, to my disgust, the poor shepherd lost his head and fell after him from sheer fright. He fell alongside of the panther on to solid rocks, breaking his arm and some ribs. The panther, in his dying effort, took the man's hand in his mouth and bit it but hadn't strength enough to break any bones. I got down below at once and polished off the beast. The poor fellow, however, although he was attended to at once by the Hospital Assistant on the forest works who was there, died 36 hours later. He complained of pain in his chest and difficulty of breathing, and, doubtless, his fall on the rocks had caused the fractured ribs to pierce his lungs. It was a sad business and I hope it may never be my fate to witness such another accident. The bad luck of the whole thing seemed to be that five out of the six bullets hit the panther (not counting, of course, the one fired into the bush) and three of these were in his head, one in the neck, the last being in the shoulder. It seems incredible that four .500 Express bullets could be placed in a panther's head and neck and not touch a vital spot. It is so very noticeable in big game shooting, that a bullet in a given spot may be fatal, if it is the first, on account of the shock caused in addition to absolute physical injury, and yet, if a bullet be put in the same place as a second or third shot, it seems to often have no effect, the real reason being that no bullet but the first causes, I think, such a shock to the animal. Be that as it may, it is an undoubted fact that a wounded animal takes much more killing, I am sure, than an unwounded one. The panther was the biggest I have yet bagged, being 7 ft. 8½ in. in length and with an extremely fine coat.

F. Z. S.

Prodigious growth of Douglas Spruce.

We extract from Mr. Henry S. Graves' article on the Douglas Spruce of Northern Oregon, in the March number of the "Forester" the following interesting table of yield and remarks relating to nine sample plots.

Summary of Sample Plots, Showing Yield per Acre at Different Ages.

Plot.	Area.	Number of trees.	Number of trees under 1 inch.	Average diameter, breast high.	Maximum diameter, breast high.	Average age.	Average height.	Contents.	Density of the forest.	Number of trees per acre.	Contents per acre.	Cords per acre.	Locality.
No.	Acres.			Ins.	Ins.	Yrs.	Feet.	Cu. ft.			Cu. ft.		
1	0.06	242	109	1.8	7	23	29.0	.....	1.0	4,033	.....	..	Clackamas. Ore.
2	0.25	701	125	2.9	10	22	38.0	1,087	1.0	2,804	4,846	..	Shelburne. "
3	0.25	168	....	6.7	16	32	69.0	1,618	1.0	872	6,451	72	Clackamas. "
4	0.25	128	....	7.1	20	41	74.0	1,118	0.8	428	4,451	51	Shelburne. "
5	1.0	645	....	7.8	17	38	81.0	8,901	1.0	645	8,901	99	Shelburne. "
6	1.0	490	....	8.9	19	37	78.0	8,036	0.85	490	8,036	90	Shelburne. "
7	1.0	360	....	10.2	21	40	85.5	7,812	0.9	360	7,812	87	Shelburne. "
8	1.0	353	....	8.9	19	50	91.1	6,742	0.8	353	6,742	76	Clackamas. "
9	1.0	150	....	19.9	40	83	139.0	17,280	0.7	150	17,280	100	L. Permelita. "

"These figures show that on a fully stocked plot there are between 3,000 and 4,000 trees per acre at twenty years of age. As the trees grow older they require greater room for their development, and in consequence many are overtopped and die. While the number of trees per acre falls off with increase of age, there are still 150 trees on Plot No. 9 at the age of eighty-three years with a density of only seven-tenths (a fully stocked area being rated as one). The most striking feature of the table is the large yield in cubic feet and cords. An examination of the last column of figures will show that the mean annual increment is something over two cords per acre."

The cord is apparently equivalent to 90 cubic feet and the mean annual increment seems to have exceeded 200 cubic feet per acre in woods 83 years old and not even fully stocked, the trees numbering 150 to the acre and averaging close on 5 feet in girth at breast height and 139 feet in height. We should be disposed to look on an acre bearing such a crop, as sufficiently densely stocked; and probably be considering whether a light thinning would not be conducive to the better development of the stems.

Cactus hedges and Fire-protection.

A fairly unforeseen use has recently been made of the Cactus in the south of France. This use consists in surrounding the young plantations of pine with hedges of *Opuntia*. This plant resists fire by reason of the great quantity of water stored in its tissues, and it was thought of as a possible means of protecting the plantations from the frequent fires to which they are exposed. One might go a step farther and, wherever the *Opuntia* can live, so increase the number of such hedges in all wooded tracts as to fence in forest fires and prevent their easy and disastrous spread.

M. Roland Gosselin has stated before the Societe d' Acclimatation that, having been present at a fire from which the *Opuntia* escaped unharmed, he was able to satisfy himself that the plants of this genus withstand admirably a hot grilling. A week after their exposure to the fire new shoots and flower buds were beginning to appear.

Herein seems to lie a system of fire-protection, which might be of great service in the Esterel and also in the Landes, provided always a kind of *Opuntia*, easy of acclimation in that latter region, can be found.

Translated from L'illustration, 11 Mars 1899.



HEAVY TEAK LOGS CARTED BY ELEPHANTS,
BURMA.

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A log-lifting Machine in use in Burma with carts drawn by elephants.

The machine for lifting heavy timber on to carts, of which a picture is herewith given, may be of some practical interest. It is used in the Thingadon forests of the Lower Chindwin district in Upper Burma, where logs have to be dragged or carted for many miles over loose sand. This machine, being very simple and very light, can easily be carried about from place to place, wherever required, and so has an advantage over the more cumbersome contrivance depicted in Mr. Fisher's "Forest Utilization."

It consists simply of an iron screw, about 2 inches in diameter, and about 4 feet long, with a square thread, working in an iron nut, which rests on the centre of a light wooden gallows about $6\frac{1}{2}$ ft. high. At the lower end of the screw is a swivel ring through which a chain can be slung, and just above the ring four iron handles project, like the spokes of a capstan, for turning the screw.

Logs which are too heavy to be rolled on to the carts in the ordinary way, are slung by a chain somewhere near the middle, and then raised by men turning the screw.

The "gin daik"—a low cart with broad solid wheels—is placed near the end of the log resting on the ground; a man now gets on to the other end of it, which is in the air, and by his weight raises the end near the cart, which is then pushed along under the lifted log, to the required position. This machine belongs to the Bombay-Burma Trading Corporation, Limited.

H. J.

The large Elm of Kulu.

In October 1876 the large Elm with drooping branches, which in Kulu is known under the name of Marn, attracted my attention. At that time I only found leaves, but a few years afterwards one of my friends sent me specimens in flower and young fruit. In May 1881 I found the same tree in the Pabar valley at an elevation of 4,000 ft., and on the ticket written by me at

the time, the vernacular name is stated as Marn. At the Herbarium here there are, besides the specimens collected by myself and by my friend, leaves and a piece of the bark gathered by the late Dr. Aitchison on the Jhelum river between 5,000 and 7,000 ft. The ticket says. "A good sized tree, bark used as rope." There is also a specimen in leaf collected by Dr. Henderson on the Yarkand expedition in 1870, and there are specimens (leaves and young fruit) collected by Dr. T. Thomson in Kashmir in 1848, at 5,000 and 5,500 ft., marked "large tree."

In his "Flora of British India," Vol. V. p. 480, Sir Joseph Hooker has united this tree with the Himalayan Elm, *Ulmus Wallichiana*. This species, however, I knew well in 1876, and had no doubt in my mind that the Marn of Kulu was different. My ticket on specimens of *Ulmus Wallichiana* gathered in Kulu in October 1876 says. "Imbri Marāl, a large tree, lopped every other year." On a specimen collected by me in May 1863 in the Amlawa valley of Jaunsar, the vernacular name is given as "Narag." I also gathered it in Bussahir at 6,500 ft. in May 1881, under the name "Imbri," and in Kunawar near Tranda at 7,000 ft. under the name "Maldang."

Ulmus Wallichiana has the young shoots and leaves always pubescent, while those of Marn are perfectly glabrous. In *Ulmus Wallichiana* the venation between the numerous parallel secondary veins is very minute, very regular and prominent on the underside, unless obscured by the pubescence. In Marn the secondary veins are also parallel and numerous (15—18 pairs), the tertiary veins are prominent, particularly on the underside, and their branches form an entirely different venation with much larger meshes, than is the case in *Ulmus Wallichiana*. The chief difference, however, consists in the fruit, which in *Ulmus Wallichiana* is glabrous, or only slightly pubescent and conspicuously reticulated, while Marn has a villous or silky fruit, with a dense fringe of long white hair on the sharp edges.

It will be a matter of considerable interest to study the Elms of the North-West Himalaya, and to ascertain, whether the "Marn" of Kulu must be regarded as a distinct species. Bark, timber, mode of growth, time of flowering, the appearance of seedlings and other characters should be studied. Both species are in flower early in the season, before the leaves appear, and in both the indehiscent flat fruit is on a long slender peduncle which is articulate near the base.

Should the Marn prove to be a distinct species in the judgment of those Foresters who have the good fortune to be working in the North-Western Himalayas, I am disposed to call it *Ulmus villosa*

D. BRANDIS.

Kew, April 1899.

Wood-pulp.

The utilization of the waste products of our Indian forests is a most important problem, but in many cases, even where the uses such material can be put to are known, there are serious difficulties to be overcome. In the case of wood-pulp, however, it is indeed to be wondered at that no enterprising capitalists come forward to develop the industry in this country.

In Europe the manufacture of wood-pulp has been going on steadily for many years, but so great is the demand for timber there, the manufacturers are able to obtain only a comparatively small supply of the raw material required. The consequence is that, although new uses of wood-pulp are discovered every day, the industry has not expanded very considerably.

It is in America, both in the United States and Canada, that wood-pulp is creating a veritable revolution in the mercantile and manufacturing world. So much so is this the case that *"The Times"* says:—

"The extraordinary development of the single manufacture of wood-pulp, which only a few years ago was practically unknown and is now used not only for making paper but for clothing and an immense diversity of other articles, is a sufficient indication of the practically limitless extension of the already widely varied uses of timber." "Cotton," it is said on the other side of the Atlantic "was once called king; but king Cotton is a lesser potentate than king Timber must soon become."

All the American papers are full of accounts of the wonderful development of the industry in that country, and of the constantly increasing uses to which wood-pulp is now put. It is in fact this industry that has brought home at last to the people of America the urgency of making State reserves, protecting them from fire and managing them systematically; for, as long as lumber only was exported from the forests the younger and smaller trees were left, but now that the wood-pulp man has appeared no trees escape, as he utilizes all the trees left by the lumber man.

The New York Tribune, referring to the numberless uses of wood-pulp and the inroads caused on the United States' Forests says:

"Printing paper alone eats an enormous hole in our national forests yearly, and the future extent of that requirement can only be conjectured. The huge procession of railway cars all over the country run, to some extent, on paper wheels; carpenters are beginning to use boards of paper, handsomely veined, requiring no planing, twice as durable as the wooden variety, and costing only half the money. The builder is introducing paper bricks, showily enamelled, which will not burn, and possess many advantages over those of burnt clay. The ship-builder

'introduces masts and spars of the same substance, which is likewise used for telegraph and telephone poles and flagstaffs. These are not fanciful experiments but serious business procedures, justified by the superior durability of the articles so produced. The same quality is claimed for the paper horse-shoe recently invented and now extensively used. An enumeration of the purposes for which this surprising protoplasm has come to be employed would stretch into a catalogue and new ones seem to be discovered every day.'

Verily we are approaching the day referred to in the chorus of the old song.

'Paper hats, paper coats, paper boots and shoes,
'Patent paper sailing ships and patent paper crews.
'On the paper market there'll be a paper strain,
'And every one, both young and old, will have paper on the brain.'

The chief wood used for pulp is spruce but silver fir is used in the Vosges mountains. Poplars, which have a short fibre, are also used but more especially for mixing with spruce pulps to give the paper a more even surface. Of spruce there is an unlimited supply in the N.-W. Himalayas, from the Bhagirati to Afghanistan, also in Sikkim and Bhutan. It grows chiefly on Northern and Western slopes between 7,000 and 11,000 feet. The species is of course *Abies Smithiana*, very closely allied to the common European spruce, *A. excelsa*. It attains a maximum height of some 225 feet, and a girth up to 16 feet. The wood is white like that of *A. excelsa* and weighs about the same, viz, 32 lbs per cubic ft. on the average.

In the Jaunsar Division alone there is a huge stock of magnificent trees, which is unsaleable at present as there is no demand for it. So much so is this the case that wherever it happens to be found growing near deodar, it is ruthlessly killed by girdling and allowed to rot, so as to favour the valuable deodar. I roughly estimate that from this Division, were the spruce put under systematic management, an annual outturn of 150,00,000 cubic feet, or about 5,70,000 maunds, equal to about 21,000 tons by weight, could be obtained. If a large quantity like this were exported it is probable that it would pay the Forest Department to sell the wood at Dagpathar on the Jumna for about eleven annas a maund.

Wood ground mechanically yields, I believe, one-third of its weight in pulp (dry) and this the paper mills would, it is supposed, willingly purchase for at least Rs. 3 per maund delivered on the railway, as their agents in the bazars are now scouring the country for old pieces of paper of all kinds which have to be sorted, washed and bleached before being of any use. For this the agents give Rs. 2 per maund and they must get a good commission for all their trouble.

Fifty-seven thousand maunds of spruce would yield some 1,90,000 maunds per annum, or 633 maunds per diem (taking 300 working days = one year) of mechanically-ground pulp and this should sell for Rs. 5,70,000.

There is not likely to be any difficulty in disposing of this quantity as the demand for paper in this country is steadily on the increase, more or less in proportion to the spread of education and trade. Moreover, if good raw material were readily obtainable by the paper mills they would not be so keen on making arrangements, throughout India, to collect all the waste paper, however inferior its quality may be.

The probable annual receipts and expenditure for such an outturn would be as follows.—

Receipts.		Expenditure.	
	Rs.		Rs.
By sale of 1,90,000 maunds of pulp, delivered at Dehra Dun Railway Station @ Rs. 3 per maund ...	5,70,000	Purchase of 5,70,000 mds. of spruce @ 11 Annas per maund ...	3,91,875
		Wear and tear of machinery and buildings @ 10 % on Rs. 1,50,000	15,000
		Manager's pay @ Rs. 800 per month ...	9,600
		Mechanical Engineer's @ Rs. 450 per month ..	5,400
		3 Foremen @ Rs. 50 each per month ...	1,800
		3 Do. @ Rs. 30 each per month ...	1,080
		60 Workmen @ Rs. 6 each per month ...	4,320
		Carting 1,90,000 maunds of pulp to Railway at 3 Annas per maund per 26 miles ...	35,625
		Miscellaneous charges ...	5,300
		Profit on capital of Rs. 5,00,000, i. e. 20 % per annum ...	1,00,000
Rs. ...	5,70,000	Rs. ...	5,70,000

The Capital required would be as follows :—

Cost of machinery	... Rs. 80,000	} Rs. 1,50,000
Setting up, leading water and erection of buildings	... Rs. 70,000	
Working Capital	... ..	Rs. 3,50,000
Total	... ..	Rs. 5,00,000

This is the prospect which seems to await any capitalist enterprising enough to take up the business ; and, if mechanically-ground pulp is able to give such a profit, what would the profit be on chemically-prepared wood fibre for paper and cloth ? For, although it is somewhat more expensive to manufacture, the yield is as much as 60 to 66 per cent. of the weight of the wood against 33 per cent. of mechanically-ground pulp. Doubtless Government would be prepared to meet any capitalist willing to start the business, with an agreement to give him the first refusal of all spruce exported, *vid* Dagpathar, at a certain rate for a certain numbers of years, as well as to lend him a plot of land for his factory with a right to lead water from the river to propel the machinery, so that he could make his own calculations as to whether it would pay him or not. Government at the same time would benefit by the opening out of a market for spruce, for which there is now no demand.

There should be no difficulty in getting water power sufficient to drive all the machinery required for the factory as, I believe, the fall of the Tons river at the foot of the hills is about 45 feet per mile. Should a market for spruce be in this way developed, it would most probably pay the Forest Department to grow spruce on a rotation of 30 or 40 years.

The Canadian pulp factories have bought up large areas of forest land which I am informed they are treating on a 20-year rotation, but then the growth of American spruces, especially the Douglas spruce, is very rapid; *vide* the tables published in "*The Indian Forester*" for May 1899.

The trees in the plantation of spruce near Deoban in the Jaunsar Division made in 1874, when the plants were put out at one year old, now average 20 feet in height and 4·6 inches in diameter ; but the plantation is not densely stocked and the locality is one with an Eastern aspect, while spruce does not apparently grow thereabouts naturally. So it is expected that with a rotation of 30 or 40 years, in places suited to the species, it would give a suitable sized tree for pulp purposes. When once a regular young forest was formed, the age at which the mean annual increment per acre culminated would be determined, and that age fixed for future rotations. It is very possible that, if experiments were made at the factory, it would be found that silver fir could also be utilized, in which case it would be advantageous to grow a mixed forest of spruce and silver fir.

It is, indeed, to be hoped that a market will soon be developed for spruce, as it is too heart-rending a sight to see all the grand trees now growing being absolutely wasted; and, as mentioned before, being girdled and allowed to rot wherever they interfere with deodar, even though the latter be seedlings, a few years old.

P. H. CLUTTERBUCK.

Jaunsar, May 1899.

Forest ground-rent.

BY CH. BROILLIARD.

Translated from the Revue des Eaux et Forêts, 15th April 1899.

In the *Revue des Eaux et Forêts* for the 10th June 1895, 10th February and 10th November 1896, M. A. Arnould took up the study of forest taxation and of the revenue survey on which it should be based. A reference to these articles will recall to mind the general principle governing this important question. It is there shown that the calculation of the assessable forest revenue must be based on the possibility, and worked out by the method of annuities. But since the interest here is compound, the difficulties of the calculation may be confusing to private owners, many of whom are not at home with such terms as annuities, compound interest, &c. We have been asked to give a summary of the matter and will now attempt to do so.

In the production of the forest revenue there are two distinct elements, or factors as they are often called now-a-days, namely, the soil and the wood. It is not very hard to discriminate the share of each. On a soil completely cleared by exploitation, the forest is reconstituted either by means of natural seedlings, by planting, or by coppice shoots. In the latter case, the reproduction being immediate, the forest re-growth is well known. What is its value? Though nothing appreciable at first, it is still the first term of the production to be realised in the future. It is therefore necessary to give a wood time to develop. It rarely requires less than 20 years for the sum of the annual growth to become a wood fit to cut; sometimes it requires a century or more before a wood becomes exploitable.

Thus, the exploitable wood, like the compound interest on a money capital, consists of the sum of annual increments, each added to those preceding, which in themselves besides acquire an increased value. All have contributed to the common work in the same manner at successive dates, drawing from the soil one year's flush of leaves. Thus it can be said, quite properly, that "this wood has put on its fourth flush"; "this coppice is in its 18th or 25th year's flush."

Each annual growth, each flush of leaves may be considered as an annuity* contributing to the total yield, not only by its own original amount, but also by means of its compound interest. The exploitation is deferred, for say 25 years, because at the end of that time the yield will include each of the annual growths, plus the interest due on each. But how can it be brought to account? By using the calculation for those annuities which allow 25 annual contributions to mount up to the outturn of the felling at the end of the term, at the rate of interest usual for forest investments in the locality.

For example, an annuity of 10 francs is paid at the end of each year for 25 years into a bank which allows 3 per cent. interest.

The bank book will show the following entries:—

For the 1st year 10 francs

" " 2nd " $10 + 10 \times 1.03$

being the second payment, plus the first payment with interest.

For the 3rd year $= 10 + 10 \times 1.03 + 10 \times 1.03 \times 1.03$

being the third payment, plus the second with interest, plus the first with two years' compound interest.

For the 4th and following years similarly:

Finally for the 25th year, the 25 annuities of 10 francs, plus the interest of the 24 earlier ones, each with its compound interest according to its date of payment; the total may be worked out or taken from tables, and amounts to 364 francs and 70 centimes.

In a forest this total is known, for it is the yield of the *coupe* the sale value of the standing wood. In a case similar to the above example, *i. e.*, for the same age and rate per cent. the annuity is what would be calculated by proportion.†

* Annuity = annual payment.

† In any case the calculation by Algebra is simple. Let a be the annuity, r the rate, and n the number of years. The sum of the annuities and of their compound interests may be written.

$$a + a(1+r) + a(1+r)^2 + \dots + a(1+r)^{n-1}$$

Now, if V stands for the value of the *coupe*.

$$V = [1 + (1+r) + (1+r)^2 + \dots + (1+r)^{n-1}]$$

The sum of the series is

$$a \left[\frac{(1+r)^n - 1}{r} \right]$$

Whence

$$a = VT \times \frac{1}{(1+r)^n - 1}$$

When r , n , and V are known, the annuity a is easily found, for the values of the factor $\frac{1}{(1+r)^n - 1}$ for all ages and for rates of interest at 2, 2½, 3, 4 and 5 per cent. are given in table III, at pages 610 and 611 of the *Traitement des bois en France*.

The soil alone produces the first year's growth, the simple annuity, and it would go on doing it every year, but actually it adds the new layer on to the wood of preceding years. The revenue of the soil for 25 years is the sum of 25 simple annuities. This is the ground-rent or share due to the soil. The share due to the wood is more complex. Its development from one year to the next is due to the material already formed. It is thus represented by the compound interest on the annuities.*

If the rate is 3 per cent. or 0.03, and the yield at 25 years is 600 francs, the amount of the annuity is

$600 \text{ fr.} \times 0.03 \times 0.914$ (table III) = 16 fr. 45c. which represents the contribution of the first re-growth. The revenue from the soil, which alone produced this first annuity, and which has produced the same every year, and would have gone on producing the same for 25 years in the open, is therefore, for 25 years, $16 \text{ fr. } 45c \times 25 = 411 \text{ fr. } 25c$.

The share of the growing stock in the production of the yield is represented by the total of the various sums earned during 24 years as compound interest on the various consecutive annuities. They work out to

$$600 \text{ fr.} - 411 \text{ fr. } 25c = 188 \text{ fr. } 75c.$$

In the above example the share due to the soil, the ground-rent, is greater than the amount due to the growing stock. But the ground-rent is not the only producing agent. The wood contributes in very various degrees.

For a simple coppice cut at 18 years, and then yielding 360 francs, the annuity would be 15 fr. 38c. thus,

$$360 \times 0.03 \times 1.424.$$

For a simple coppice cut at 36 years, and yielding 1,200 francs, the annuity or ground-rent would amount to

$$1200 \times 0.003 \times 0.527 = 18 \text{ fr. } 97c.$$

The above examples refer to crops of one age over the whole of the area exploited periodically.

In a coppice under standards cut at 30 years, the *coupe* being worth 600 fr. from the coppice and 900 fr. from the standards cut, the annuity for the coppice would be $600 \text{ fr.} \times 0.03 \times 0.701$ (table III) = 12 fr. 62c. The annuity for the standards, supposing their mean age to be 90 years, would be $900 \times 0.03 \times 0.075 = 2 \text{ fr. } 03$. The total annuities, or ground-rent is thus 14 fr. 65c. The share of the growing stock in the production of revenue necessarily increases greatly with time. In this instance, the share due to the soil, being $14.65 \times 36 = 527 \text{ fr. } 40c.$, is already less than the amount due to the growing stock, which is 972 fr. 60c.

* Algebraically, the share of the soil in the yield of the *coupe* is na ; and the share of the growing stock is $V - na$

In a high forest cut at 120 years and yielding at that age 10,000 fr. per hectare (including thinnings and their interest) the annuity at 3 per cent. would be:

$$10,000 \times 0.03 \times 0.055 = 16 \text{ fr. } 50\text{c.}$$

Such are the revenues derived from the soil, the ground-rents, of our high forests, the soil of which is seldom in itself capable of yielding a high return. Great results are only obtained by means of prolonged economy and by the action of the growing stock which goes on growing, and of the forest which fertilises the soil as time goes on. If more convincing proof is desired, it may be found by comparing the revenues derived from pastures or waste lands with those accruing from the broad-leaved or coniferous forests adjoining and by ascertaining the value of land given up by agriculture for reboisement. Hence, it is clear that when the *Recueil méthodique des lois et règlements sur le cadastre* laid it down that high forest was to be valued at the same rate as coppice, there was certainly no undue favour shown to the former. Probably they did not suspect that there was any difference.

In all the above examples the rate of 3 per cent. has alone been used, to avoid complications. But the rate in practice may be some other, and it is easily seen, on reference to table III above quoted, or by direct calculation, that a lower rate gives a higher ground-rent, and the converse.

There is another consideration. Starting from the sale value of the *coupe*, what is determined is the *gross* revenue. The *net* revenue must be found by deducting the cost of watching, up-keep, plantations, &c.; so that if these expenses amount to 2fr. 50c. per hectare per year, the gross revenue must be reduced by that amount in order to arrive at the true assessable revenue.

The method above analysed supplies the necessary basis for determining the ground-rents of every survey division, apart from any idea of working plans, it is also perfectly applicable to forests under working plans, for it is independent of the age of the wood at the time of valuation.

Private owners of forests have no need to be agitated by compound interest calculations. Any schoolmaster teaching arithmetic can handle them, and they need not be put into practice in order to become explanatory of the facts. The use of algebra is an amusement or a bore, according to the frame of mind one is in. I can to this day recall the scene, when a young B. A. candidate, unknown to me, came up to the black board and was examined as follows:—

“What is the annual payment *a* necessary to pay off in *n* years a debt of *A*, at *r* per cent?”

No answer.

“Write *a*, *n*, *A*, *r*,”

The unfortunate student, writing with white chalk, nevertheless could see nothing but the black board, and remained

dumb, as did the examiner. After two cruel minutes of waiting he was dismissed. I do not know if he knew anything or not, but it would have been easy to find out.

"What happens to an annual payment at the end of a year, 2 years, *n* years?"

"What should be the sum of these payments?"

"Continue."

After all, it was only an affair of summing up a series. Triumph of the schoolmaster *emeritus*, and stupefaction of the candidate, who must surely have learnt it. Never did I see a worse piece of examining. So be not afraid of a black board. There is but an idea to master and here it is.

The annual ground-rent of a wooded soil is nothing more than a simple annuity, while the sale value of the *coupe* includes the accumulated revenues of both soil and stock. That is all. The soil, a natural agent, has a constant action on the wood production. If in time it gains in quality it is by the action of the forest itself, which burrows in it and enriches it. The wood, a natural agent, forms on a given soil an increment every year by means of increasingly numerous organs, leaves, rootlets, &c. Needless to pursue further the analysis of the action of the soil and of the wood by which the value is complicated.

It remains to say a few words, on a most delicate question, that of the possibility. It has been laid down that the valuation of the taxable revenue should be based on the possibility; this is quite right and correct. But how is this amount to be fixed for each survey area, or for a given forest. Every calculation of the possibility depends to a considerable extent on individual appreciation. The first necessity, indeed, is to fix the exploitable age, then the yield in material, and the rates for different classes thereof, so as to deduce therefrom the money value of the saleable *coupe*, 600 francs every 25 years for instance. The fixing of the ground-rent should take count neither of the age of the existing wood, nor of the working plan in force, nor of recent removals of material, nor of the circumstances peculiar to each owner, which the latter may have himself arranged for his own pleasure or convenience. The matter to be determined is the revenue of which the soil is capable, and that with moderation. In a general way, granting the above, the possibility should be based both on the ordinary amount of cutting in the locality, and on the value of wood in the particular forest.

Thus, as the first thing is always to divide wooded soils into classes by fixing the net revenue per hectare to be expected from each, the appreciations of the classifying valuers should be limited to fixing the class to which a given area belongs, irrespective of its actual condition and irrespective of its owner.

F. G.

Fire-protection in the Minbu Division, Upper Burma.

The Reserved forests of the Minbu Division are exceedingly dry owing to their situation in the "dry zone" of Upper Burma and to their constitution, which is generally a *Acacia Catechu* with a large admixture of such species as *Tectona Hamiltoniana* and *Terminalia Oliveri* and characterised by the prevalence of the Bamboo, *Dendrocalamus strictus*, which loses its leaves very early in the year; so that, as a rule, these forests are almost leafless from the middle of January and in dry years even earlier.

The cover, moreover, owing to the annual fires which have passed over the forest for a long series of years, has been more or less interrupted, and the ground covered with a dense growth of long coarse grass which prevents any natural reproduction, makes the forest very inflammable and increases the difficulty of extinguishing a fire when it has once broken out.

These forests are, therefore, in great need of special fire-protection; they are at the same time difficult to protect, since, in addition to the difficulties presented by the situation and nature of the forest growth, sudden strong winds, of more or less variable direction at first, settling to the south later, are experienced from the beginning of March and last for the rest of the fire season, which commences from the middle of January and ends about the beginning of June.

The prevalence of "Taungya" cultivation and the firing of the forest *outside* the narrow fire-line cleared round the "Taungya" (which is done by the Taungya cutter shortly after he has felled the growth on the area he intends to cultivate, thus fire-protecting the Taungya and preventing the cut growth being prematurely burned) constitutes a real danger from the outside.

The naturally careless disposition of the Burman, and the still more careless nature of the Chin render the passage of these people through the Reserves a source of danger from within, which is considerable, as villages on the borders of the Reserves are very numerous, and journeys frequent during the hot weather, when the people have little work to do, and festivals, Chin drinking parties, and other social meetings help to pass the time.

In one Reserve the simultaneous outbreak of fires in several spots, inside the fire-trace, points to incendiaries and though in that Reserve suspected incendiary fires have unfortunately occurred annually since fire-protection was commenced in 1895, no offender has ever been caught. The theories advanced regarding these suspected fires are various; they may be started by cattle owners for the sake of grazing, or by persons having a spite against some of the fire watchmen, and it has been suggested that they may be caused by right-holders, who in their ignorance think that, if once the Reserve is burnt over, they might possibly

be allowed to extract produce in satisfaction of their rights during the fire season, which is not allowed by the settlement.

The hilly nature of the ground and the want of means of communication add to the difficulties of supervision; the forest staff is also weak, both numerically and in training.

The cost of fire-protection in the Minbu Division is unavoidably kept up by the scattered, isolated disposition of the Reserves (which could not be taken up in large blocks owing to numerous intervening villages). The Reserve boundaries, also, do not favour fire-protection; as the exclusion of low lying lands (called "kyins" and suitable for cultivation) at the bends of the streams and at the mouths of feeders diverts the boundary from the main stream banks, thereby increasing the length of artificial fire-lines. Labour though abundant, is, as usual in Burma, highly-paid, unskilled coolies earning Rs. 12 per month or As. 8 a day if hired for short periods.

Such were the conditions under which fire-protection was commenced in 1895, when an attempt was made to protect the Tichaungwa Reserve—14,080 acres. But before the fire-lines were completed, fire spread into the Reserve and a large area was burnt over. A second big fire occurred later and eventually only an estimated area of 3,200 acres escaped. The cost of the work was Rs. 736.

It is to be noted that villagers called upon to assist in putting out the fires refused to obey. They have in more recent years been educated into rendering assistance.

In 1896 the Tichaungwa Reserve fire-protection was much more successful. The northern part of the Reserve was excluded from the protected area as it was thought that the grazing to which it was subject was a source of danger; the area over which protection was attempted, was thus reduced to 11,520 acres, and fire was kept out of 10,240 acres. The 1,280 acres estimated as burnt over suffered through incendiary fires. The cost for the year was Rs. 962.

In 1897 the same portion of the Tichaungwa Reserve was fire-traced, but the result was exactly the reverse of the previous year. Fires occurred at intervals from January to April and were thought to be incendiary; 10,240 acres were burnt over and only 1,280 acres escaped. The cost of protection was Rs. 701.

In 1898 protection was again attempted over the same area of the Tichaungwa Reserve, but the fire-traces were widened and proved effective, as in no case did fire cross any of them. Five fires occurred during the fire season, and 1,472 acres were burnt over; the cause of none of these fires was proved, but they were probably incendiary, as they all commenced inside the fire-traces and at a distance from them.

A portion (4,160 acres) of the Mon west Reserve was placed under fire-protection in 1897 and the whole escaped fire. The cost was Rs. 553. The same area was again protected in 1898

(with the exception of 14 acres which were burned through carelessness when firing the trace) at a cost of Rs. 455.

The only other fire-protection undertaken up to this year (1899) was to protect isolated catch plantations and this was successful, but the area dealt with was small.

This year, fire-protection was attempted over the usual area in the Tichaungwa Reserve, extended over a very much larger area in the Mon west Reserve, and 12 square miles of the Pazu Reserve were, for the first time, brought under protection. The results cannot yet be noted but it may be mentioned that several incendiary fires have unfortunately occurred in the Tichaungwa Reserve.

There can be no doubt of the very great importance of extending fire-protection in these forests. The main difficulty lies in the want of a better trained and more trustworthy subordinate staff, and this we hope will result from the Burma Forest School, long talked of and now soon to be established.

C. E. MURIEL,

BURMA.
16th May 1899.

Podophyllum Emodi.

*The Inspector-General of Forests has recently issued a Circular to Conservators drawing attention to the value of the roots of *Podophyllum emodi* (vide Imperial Institute handbook No. 3), and suggesting that every endeavour should be made to start a trade in it with the drug merchants of Bombay and Calcutta. It has been reported from the Imperial Institute that it has been proved that the Indian drug is a complete and satisfactory substitute for the American product (*P. peltatum*), the chemical constituents of the former being identical, both in their composition and action, with those of the latter. The*

development of the utilization of *P. emodi* for the extraction of "podophyllum," for which there exists a considerable demand in English and Continental markets, is therefore a matter of some importance, and enquiry is made as to what steps can be taken to secure the object in view.

Salem Iron Ore and Sanctoria Coal.

The following memorandum by Professor Dunstan of the Imperial Institute is abstracted from correspondence communicated by the Madras Government.

*Memorandum on the trials by Messrs. Bolckow, Vaughan & Co.
of samples of Salem iron ore and Bengal coal.*

In connection with the correspondence which has taken place between Mr. H. G. Turner and the India Office with reference to Mr. Turner's application for a concession to smelt the Kanjamalai ore, I wish to draw attention to the following points.

In 1892 Mr. T. H. Holland, Assistant Superintendent of the Geological Survey of India, was deputed by the Government of India to secure for the Imperial Institute a representative collection of the iron ores of Madras. In transmitting the collection of samples Mr. Holland suggested that they should be experimentally examined (*see* Sir E. Buck's demi-official letter, No. 1088-29, to Sir Frederick Abel, dated 5th May 1892, F. S. S., No. 26).

The specimens were accordingly submitted to analysis in the laboratories of the Imperial Institute, and the result published in the Journal of the Imperial Institute, volume 2, No. 18 (June 1896).

This collection included six samples of ore from Kanjamalai in the Salem district of Madras, which, on analysis, furnished the following results :—

Number.	Available iron.	Insoluble residue (Silica).	Lime.	Sulphur.	Phosphorus.
799	68.95	1.04	...	.16	.13
815	70.08	1.72	...	.20	...
873	63.57	8.89	...	.29	...
874	66.96	3.17	...	.10	...
812	36.44	46.95	...	.18	...
813	35.73	48.45	...	.29	.27

The average percentage of available iron is thus 56.95, the highest percentage being 70 and the lowest percentage 36. Out

of the six samples, four were therefore of excellent quality and only two inferior. The four samples are undoubtedly suitable for conversion into pig iron by smelting on the large scale, whilst the two samples are valueless for this purpose.

A specimen of the consignment of ore specially selected this year by Mr. Middlemiss, of the Geological Survey of India, for transmission to Messrs. Bolckow, Vaughan & Co., as typical of the Kanjamalai deposit, referred to in his memorandum of the 6th February 1898, furnished on analysis in the laboratories of the Imperial Institute the following results, which are in substantial agreement with those obtained by Messrs. Bolckow, Vaughan & Co., and recorded in their letter of the 28th July 1898 (*see* appended report on Salem ore and Sanctoria coal by Mr. J. E. Stead). In the following table, column 1 gives the results of the analysis made in the Scientific Department of the Imperial Institute, column 2 the results of Mr. Stead :—

	Imperial Institute,	Mr. Stead.
Iron ... ..	... 38·74	39·02
Insoluble residue (silica) ...	... 44·09	42·36
Lime ... ..	.. ·365	1·00
Sulphur ... ..	... ·076	·03
Phosphorus ... ..	... ·14	·13

It is therefore clear that the specimen of Kanjamalai ore, regarded by Mr. Middlemiss as representative, is extremely poor and quite unsuitable for smelting in the blast furnace. In connection with the favourable opinion expressed by Mr. Jeremiah Head in his report to the Secretary of State, dated 11th March 1898, as to the possibility of smelting the Kanjamalai iron ore, it should be pointed out that he has taken, as provisionally representative of the ore, the results of the analysis of the best specimens from the Imperial Institute set, and has taken no account of the recorded results of the analysis of the two inferior specimens (Nos. 812 and 813) which correspond with the samples regarded by Mr. Middlemiss as an average representative portion of the Kanjamalai deposit.

Turning to the coal. One hundred tons of Bengal (Sanctoria) coal were forwarded to Messrs. Bolckow, Vaughan & Co. A sample from this consignment analysed in the Scientific Department of the Imperial Institute furnished the following results :—

Calorific value—6,237 calories.
 Fixed carbon—52·83 per cent.
 Volatile matter—25·94 per cent.
 Sulphur—·168 per cent.
 Phosphorus,—·039 per cent.

These results again are in substantial agreement with those obtained by Messrs. Bolckow, Vaughan & Co., from Mr. R. Robinson, and referred to in their letter of 28th July 1898. This

sample of Sanctoria coal is, however, inferior to the two samples described in my "Report on the Coal Supply of India, 1898," which were sent to the Imperial Institute as representative of the coal of this colliery. The analysis of these two samples gave the following results :—

	Serial number.	Fixed carbon.	Volatile matter.	Sulphur.	Ash.
	1,163	49.4	39.3	1.63	11.29
	1,168	49.32	39.94	1.53	10.74

It therefore appears that the consignment of coal sent to Messrs. Bolckow, Vaughan & Co., whilst containing a smaller proportion of sulphur, is much richer in mineral constituents (ash) than either of the two samples referred to in my Coal Report, there being, in fact, nearly twice as much ash in the coal consigned to Middlesborough, which, moreover, is stated to yield an unsuitable coke. Consequently I agree with Messrs. Bolckow, Vaughan & Co., that this sample of Sanctoria coal is unsuitable for smelting purposes.

We may, therefore, conclude that if the sample of Kanjamalai ore is, as Mr. Middlemiss asserts, an average specimen of this deposit, this ore cannot be seriously regarded as suitable for smelting, even after treatment by the magnetic separator. Similarly, if the sample of Sanctoria coal sent to Middlesborough is the only coal available for use in the blast furnace, then iron smelting can hardly succeed in Madras.

I am, however, of opinion that neither of these two points has been established. As regards the ore, Mr. Middlemiss remarks :—

"Only occasionally, in small pockets or as veins or local accretions (not more than a few inches across), do we sometimes find masses of pure, or almost pure, magnetite. But it would not be fair to include these in any estimate of the general richness of the beds. It is doubtless due to some such specimens as these having been gathered that some of the analyses of the Kanjamalai ore carried out at the Imperial Institute gave such abnormally rich percentages of iron (about 70 per cent)."

Now, the specimens of ore referred to by Mr. Middlemiss as having been analysed at the Imperial Institute were selected by Mr. T. H. Holland as typical portions of the deposits. Four out of the six specimens are undoubtedly excellent samples of magnetite, which would repay smelting, whilst only two were of the inferior quality regarded by Mr. Middlemiss as representative. It is evident that, before any conclusion can be arrived at as to the value of the Kanjamalai deposit, it must be systematically sampled and analysed. I agree with Mr. Jeremiah Head's recommendations on this head.

250 RUBBER FROM THE CEARA RUBBER TREE IN MADRAS.

As to the coal. I have no information with reference to the selection of the sample sent to Middlesborough. As I have pointed out, it is inferior to the sample of Sanctoria coal specially selected for analysis at the Imperial Institute by the Reporter on *Economic Products to the Government of India*. Of the 53 samples of coal derived from the various Bengal collieries and described in my report, a number would probably be suitable in composition and coking power for use in smelting iron ores.

The fuel question, therefore, requires further investigation before any decision as to the suitability of Bengal coal can be arrived at.

10th November 1898.

Q Rubber from the Ceara Rubber tree in Madras.

In reply to a communication from the Board of Revenue, Madras, relative to the extraction of rubber from the Ceara rubber tree (*Manihot Glaziovii*) Mr. D. Hooper, Officiating Reporter on Economic Products to the Government of India, wrote in December last as follows:—

“ I do not think I could do better than enclose a copy of my report on the analysis of a few pounds of the powdered bark received from Mr. Proudlock in October last. The results of the experiments show that the scheme of preparing rubber from the dry bark of this introduced tree is impracticable.

‘ I have since made a microscopical examination of the inner bark with the result that, while the laticiferous vessels or caoutchouc ducts are not absent, they are scantily distributed in the bark and are undeveloped and in some cases empty.

‘ While the cultivation of the ceara rubber trees has been fully established in Southern India, it is a matter for regret that the climatic conditions or soil are not suitable for encouraging the secretion of rubber in the trees to make their introduction a commercial success.

COPY of report on the analysis of the powdered bark of ceara rubber tree (*Manihot Glaziovii*), by D. Hooper, Esq., F.I.C., F.C.S., F.L.S., Officiating Reporter on Economic Products to the Government of India.

In October last a sample of a few pounds of ground bark from the ceara rubber tree was received from Mr. Proudlock, Curator of the Botanic Gardens, Ootacamund.

The facility with which the tree grows in certain localities in South India where the tree has been experimentally planted, encouraged the hope that the juice would be secreted in large quantities and the raw rubber made available for the home market. These expectations were

not realised, since it was found that several well-established trees refused to "bleed" when the bark was cut during the dry weather, and the small quantities afforded by other trees growing in more favoured situations were not sufficient to pay for the expenses attending their cultivation.

It was next thought probable that the rubber might be extracted by some simple process from the stem bark of the mature trees.

An experiment was made in this direction in 1886, when Mr. L. Wray, Junr., of Perak, forwarded to London a sample of bark of *Payena Leorui* (*Gutta Sundeh*) for valuation and report. The bark was duly analysed and found to contain over 18 per cent. of gutta and resin. The recovery of the rubber by means of solvents involves such a loss that it was considered at the time that the material was useless and the process of separating the rubber was too expensive.

The bark in question was boiled, for two hours with benzol, the solution filtered and the solvent recovered by distillation. The residue was treated with spirit to dissolve adherent resins, and the caoutchouc weighed. The amount was equal to half of one per cent. of caoutchouc on the air-dried bark. Another estimation was made with boiling chloroform in the ordinary way, and the total dry resinous extract obtained by means of this solvent was less than one per cent.

The cultivated ceara rubber bark contains such a minute proportion of rubber that it would be useless to endeavour to extract it by artificial means. The bark operated upon contained 12 per cent. of water and a large quantity (17.5 per cent.) of mineral matter. A trace of tannin, a little red colouring matter and some starch were the only other noticeable constituents in the material.

In the Forbidden Land.

By Henry Savage Landor.

It is nearly eighteen months now since Mr. Henry Savage Landor returned from his travels in Thibet : but the Rougemont *fiasco* and the recent correspondence between Mr. Landor and the Secretary of the Royal Geographical Society regarding the geographical inaccuracies contained in his book, *In the Forbidden Land*, has caused a great deal of attention to be drawn to the achievements of this remarkable traveller. Sufficient has appeared to show that Mr Henry Savage Landor is in no way to be trusted as regards the scientific results of his travels ; but Forest Officers who frequently have to undergo great hardships, who frequently have to put up with many discomforts in the ordinary course of their duties, will read with great interest, if not with amusement, of some of Mr. Landor's exploits, which have been collected from the pages of his book.

The Forest Department doubtless contains many officers who are renowned for their walking capabilities. Many authenticated stories could be related. It will be sufficient to mention the exploits of the young forest officer in the Chanda District, of the Central Provinces, an ardent shikari, who, having received *khubber* late in the evening of a tiger-kill, at once started off and walked over 50 miles during the night to shoot his tiger in the morning. Such officers will appreciate Mr. Landor's achievements ; especially as they were, without exception performed under the greatest climatic difficulties.

Thus, for instance, on page 166 of his book Mr. Lander relates his adventures at 22,000 feet elevation.

"Exhausted and seized by irresistible drowsiness, the Rougba and I, nevertheless, at last reached the top. Although almost fainting with fatigue, I registered my observations. The altitude was 22,000 feet, the hour 11 p.m.

The ascent from the glacier at the bottom of the mountain to the summit occupied $4\frac{1}{2}$ hours; the precipitous descent, without counting stoppages only the ninth part of the time. Over the same trying stony valley we reached camp during the early hours of the morning. The distance from camp to the altitude reached and back was over ten miles: therefore, during the 24 hours I had altogether gone 18 miles (*quite a record at such great altitudes*). I may here also remark that, since breakfast at 6 o'clock the previous morning, I had taken no food of any kind, thus making an interval of 23 hours between one meal and the next."

But Mr. Lander's capabilities of walking at great altitudes without food of any kind appear to be quite exceptional. For, again, on page 220, he tells us regarding his walk at 16,500 feet elevation.

"With the exception of a handful of oats, this was the first solid meal we had for 48 hours. In those two days we had travelled twenty miles, at 16,500 feet elevation, each of us carrying considerably over sixty pounds."

And, moreover, these strolls over dangerous ground and at great altitudes were not carried out under the most favourable conditions as may easily be gathered from the following.

Page 213. "At last, after endless trouble, threats and promises, Bija Singh, the Pahari, was persuaded to come. But the load was too heavy for him; he would only carry half. To save trouble, I agreed I would carry the other half myself *in addition to my own load*. We put out our hurricane lantern, and at 2 p.m. when the gale was raging at its highest, driving the grit and snow like spikes into our faces; when the wind and cold seemed to penetrate with biting force to the marrow of our bones, a handful of silent men, half frozen and staggering, left the camp to face the blizzard. It was so dark that we could only see a few inches in front of our noses."

Under such conditions it is only to be expected that Mr. Lander had some really narrow escapes in the course of his walks. It is only possible here to quote one of the many that were hair-breadth:—

Page 92.—"The higher I got the harder and more slippery grew the snow. The soles of my shoes having become soaked and frozen made walking very difficult. At 12,000 feet, being about 300 feet above the stream, I had to cross a particularly extensive snowfield, hard, frozen, and rising at a very steep angle. Some of my coolies had gone ahead, the others were

behind. Notwithstanding the track cut by those ahead, it was necessary to re-cut each step with one's own feet, so as to prevent slipping. This was best done by hammering several times into the white sheet with the point of one's shoe, until a cavity was made, deep enough to contain the foot and to support one upright.....I had not the patience for that. I thought I had found a quicker method, and by raising my knee high, I struck the snow with my heel, leaving my foot planted until the other one had, by the same process, cut the next step. It was in giving one of these vigorous thumps that I hit a spot where, under a thin coating of snow, was hard ice. My foot failing in its grip, slipped, and the impulse caused me to lose my balance. I slid down the steep incline at a terrific pace, accompanied in my involuntary tobogganing over ice and snow by the screams of my horror-stricken coolies. I realised that in another moment I should be pitched into the stream, which would have meant being carried under the long tunnel of ice to meet certain death beneath it. In those few seconds I found time to speculate even as to whether those stones by the water's edge would stop me, or whether the impetus must fling me past them into the river. I attempted to get a grip in the snow with my frozen fingers, to stem myself with my heels, but with no success, when I saw ahead of me a large stone rising above the snow. With desperate tension of every nerve and muscle, I knew as I approached it, with the foaming water yonder, that it was my only hope. I consciously straightened my legs for the contact. The bump was tremendous, and seemed to shatter every bone in my body. But it stopped me, and I was saved—only a few feet from the water's edge—miraculously, although fearfully bruised, with no bones broken. My fingers were cut by the ice and bleeding; my clothes were torn to atoms."

As for hardships, the journey from beginning to end was naturally one long series of hardships. The following, however, may be found interesting. At page 218 we read about a night spent at 18,000 feet elevation:—

"At last the morning came! When I tried to raise the blanket in order to sit up,.....it was frozen hard, and as rigid as cardboard, covered over with a foot of snow."

Again, page 212,....."even in my reduced condition I was able to stand an unusual degree of cold. As a matter of fact, the water that had been taken from under the ice immediately froze on my shoulders, with the result that in a second I had icicles hanging on each side of my neck and a shawl of ice over my shoulders"!! (*The points of exclamation are ours.*)

Mr. Henry Savage Landor, however, is not only a pedestrian and mountaineer of the first order, but also, if his own accounts are to be believed, a powerful swimmer and here again quite uninfluenced by temperature. Two of his experiences in frozen water will suffice to establish his reputation,

Page 44.—“Notwithstanding the faith that Chandan Singh and Man Singh had in my swimming, they really thought that their last hour had come when I took each by the hand and asked them to follow me into the stream. Hardly had we gone twelve yards when the inevitable took place. We were all three swept away, and Chandan Singh and Man Singh in their panic clung tight to my arms and dragged me under water. Though I swam my hardest with my legs, we continually came to the surface and then sank again, owing to the dead weight of my helpless mates. But at last, after a desperate struggle, the current washed us on the opposite side, when we found our feet and were soon able to scramble out of the treacherous river. We were some 200 yards down stream from the spot at which we had entered the river, and such was the quantity of muddy water we had swallowed that we all became sick.”

But not content with swimming across a mountain torrent with two coolies clinging to him, Mr Landor must needs go one better :—

“I swam fast to the animal (yâk) and, with no small exertion, pulled him ashore, some two hundred yards further down the stream ”

The portions of Thibet traversed by Mr. Landor do not appear to have abounded in game ; and, perhaps, for the sake of the animals this is just as well. They would certainly have stood little chance, if the following adventures are to be taken as fair samples of his prowess :—

Page 67.—“There, there ” ! they all screamed at the top of their voices pointing to the summit of the opposite cliff, over four hundred yards distant I put up the Lyman back-sight to 400 yards, took aim and fired. Down came, rolling from rock to rock, the poor wild goat.”

Again page 255.—..... “and we continued our journey along the water-edge of the Davies’ Lake (Rakas-tal) where occasionally hares sprang from under our feet, *several of which I killed with my rifle, using bullet cartridges.*”

In his speech at the distribution of prizes at the Imperial Forest School, Dehra Dûn, in March last, Mr. Ribbentrop is reported on page 171, of the *Indian Forester* to have said. “It has happened, before now, that officers in our service have lost their way in the jungle, and for days have had to exist on forest produce and monkeys, and under such circumstances a strong digestion is by no means to be despised. I have never been able to think of a proper test, or I should have given another prize for the best digestion.” Mr. Landor should indeed compete for this prize. On page 197 he tells us.

“In a corner of Wilson’s tent was a very large quantity of candied sugar—many pounds ; and so famished was I that I quickly devoured the lot.”

But Mr. Landor must look to his laurels, for his servant appears to run him close :—

"Man Singh was found sound asleep, several miles back, lying by the side of the empty butter pot, the contents of which, 5lbs., he had devoured."

It would be interesting to know whether other Himalayan travellers will bear out the following :—

Page 217.—"Experience had taught them that eating cold food at great altitudes is more dangerous than eating no food at all."

On his return from Thibet, Mr. Landor spent a good deal of time round Naini Tal, and officers stationed in those parts of the Himalayas will remember him as a very small, weakly, emaciated and insignificant-looking youth, with a somewhat Mongolian type of countenance. Indeed, he himself, at page 62, tells us that he was soon nicknamed "the monkey, a name of which I have been proud ever since."

Those who have seen him will be able the more to appreciate the great deeds of valour of this modern Baron Munchausen. Three anecdotes must suffice :—

Page 144.—"A matchlock was now being loaded by a soldier, and such was the quantity of gunpowder they placed in the barrel that I made sure whoever fired it would have his head blown off ; so it was with a certain amount of satisfaction that I saw it handed over to the Pombo. That official placed the weapon against my forehead, then a soldier leaning down, applied fire to the fuse and eventually there was a loud report which gave my head a severe shock, and the over-loaded matchlock flew clean out of the Pombo's hand, much to everybody's surprise. I forced myself to laugh....."

Page 208.—"Among them I noticed several of the men who had betrayed me, and as I was told that there was no way of punishing them for treachery, I took justice into my own hands, proceeding with a stout stick to teach them some idea of faithfulness, whereupon the whole village ran up to get the fellows out of my clutches. Encouraged by the Thibetans, the Jhokas made some insulting remarks about Englishmen ; so the fight became general until, ill as I was, and alone against some hundred and fifty (150) men I succeeded in routing them. The thing might justly be doubted had I not been able to take a snap-shot of them as they fled helter-skelter."

Page 24.—"As I saw them take out a flint and steel to light the fuses of their matchlocks, I thought I might as well have my innings first, and before they could guess at my intention, I supplied a violent blow with the muzzle of my rifle to the stomach of the man nearest to me. He collapsed, while I administered another blow to the right temple of another man who held his matchlock between his legs, and was on the point of striking his flint and steel to set the tinder on fire. He, too, staggered

and fell clumsily they retreated, promptly laying down their weapons."

Mr. Landor does not explain why he did not on this occasion also apply his usual nostrum, *viz.* "I made him lick my shoes clean with his tongue" (page 107).

On the whole, *In the Forbidden land*, if taken in the right spirit, is a sufficiently entertaining book of travels, and will supply a goodly number of anecdotes and experiences to relate round the camp fire. On the other hand, if the stories have to be taken *cum grano salis*, perhaps Mr. Landor is not wholly to blame, if we accept his own version as to the method in which his notes were kept, namely:—

"I managed, at considerable risk, to keep a rough record of the journey back, on a small piece of paper that had remained in my pocket when I had been searched by Thibetans. As I did when on the rack, I used to draw my right hand out of its cuff, and with a small piece of bone I had picked up as a pen, and my blood as ink, I drew brief cipher notes and a map of the whole route back.

A. C.

A great stroke of Luck.

A Forest officer having to spend eight months of each year in the jungles, naturally turns to sport as his chief relaxation from work. At the beginning of each camping season most of us no doubt anxiously wonder what good fortune in the shooting line is coming our way. Of course the prospect varies immensely according to the forests one happens to be in charge of at the particular time.

At the beginning of December 1897, I was in one of the easternmost districts of the North-Western Provinces. On starting into camp my wife and I made up our minds that the best bag we could hope for this season might consist of a few good spotted stags, and a possible panther if luck favoured us. It has often been noticed, however, that in shooting as in most other things, the best luck comes when it is least expected. This occasion proved itself no exception to the rule.

My wife and I started from head-quarters on December 3rd, visiting some outlying detached blocks of forest before going to the main forests. The next day, when inspecting the forest, I found numerous tracks of a panther along an unfrequented path. I ordered a young goat to be tied up. Now, panthers in this part seem different to those in any other district that I have been in. They will not as a rule, kill a bait, whether goat or buffalo calf, tied out for them. This must be due, I think, to the fact that wild animals are rendered easy prey to them by the tall grass, 5 to 10 feet high, which characterizes the lower levels of the forest lands in this district. Be this as it may, I had had baits tied up constantly during two seasons but not a panther would touch them, although tracks were frequently observed close to them. The panthers were altogether too clever and evidently suspicious of a tied-out animal. So, when I ordered the goat to be tied out I had little hope that the panther would be induced to take it. I was quite surprised next morning to hear the goat had been killed. Inspecting the spot I found that the panther had eaten all except the head and a small piece of the neck; so I decided to sit up in the evening over a live goat tied at the same place. Having been delayed at work, I was not ready to sit up till about an hour before dark. As I turned the corner, on nearing the spot, I saw the panther, about 200 yards away, sneaking off along the path towards the high grass to the south of the forest. He saw me and turned off into the jungle. My men, having quickly tied up the *machan*, waited till I was settled, then tethered the live goat at the further edge of the line. They departed, talking loudly, to let the panther know they had gone.

The line, near the edge of which I was posted, ran nearly north and south through the centre of the forest. It was cleared of trees for a width of 15 feet and in the middle an inspection path had been cleaned six feet wide. On either side the forest was fairly dense consisting of *sāl* (*shorea robusta*) poles with a good deal of undergrowth. About half a mile to the south the *sāl* forest abruptly terminated in heavy grass, some 8 feet high, in the direction of which I had seen the panther retreating. My *machan* was on the eastern side of the line, a few yards inside the forest, and the goat was tethered on the western edge. The goat called vigorously to the retreating men, imagining it had been left by itself, since it had not been allowed to see me climb up into the *machan*. This soon attracted the panther; for, before half an hour had elapsed I got a fleeting glimpse of him in among the undergrowth on the further side, *i. e.*, west, of the goat. He then evidently crouched for some time, taking in the surroundings. But the goat did not seem aware of his proximity. Suddenly, having made up his mind that all was safe, the panther began playing with him, making repeated feints, as if he were

going to seize him. The goat, a small male about 18 months old, although no doubt very frightened, was most plucky, and keeping his head towards the panther, butted the air, and snorting, stamped with his fore feet. It was now dusk, but a bright moon was shining. I could not see the panther at all, as all this performance was going on under the dense undergrowth, but could hear his pretended rushes and could see the goat's antics well. After about a quarter of an hour of this by-play the panther dashed off towards the west, further into the jungle, away from the goat. The latter seemed very pleased but continued to look in the direction the panther had taken, hardly daring, I suppose, to believe that the panther had really gone. I was beginning myself to think that he had seen me and hastily retreated, since for the next quarter of an hour hardly a sound was heard in the still moonlight. The goat continued looking steadfastly in the direction the panther had gone quite unaware that the latter had only departed to make a detour, preferring to stalk him from behind than to face his determined butting. I myself was not aware that this was the case, until I suddenly saw him sneak out of the forest on my side of the line, worming himself along with his belly touching the ground. As he entered the band of bright moonlight of the line, he was only some 20 or 25 feet away from me. I hastily took a snap-shot with my Express and had the satisfaction of seeing him roll over, without a sound, in the middle of the six-foot path.

The surprise of the goat must have been great. He was indeed delighted, when I holloaed for the elephant, to find that a man was near him after all. When the elephant was approaching I kept my eye on the panther, but not seeing even a twitch in his tail I concluded he was dead. I got down and, having thrown two or three clods at him without effect, approached carefully towards his tail end to see where the bullet had hit him. I found it had broken the backbone, so knew from the position of the *machan* that it must have reached his heart, and lungs as well, and that there was no fear of his not being really dead. My orderly, who came with the elephant, and I held the brute up while the *mahaut* tied him on to the pad of the elephant. I did not like the job however, as the panther felt so warm and life-like. He was a small male, just over six feet long, with lovely fur.

Thus, after two days only of camp, the possible bagging of a panther became a *fait accompli*. My wife and I agreed that this ought to be a good omen for the success of the season. So it turned out.

It would be difficult to imagine our excitement when, a few days after, we heard that a rhinoceros had appeared in the main block of forest, at least, said the report, the tracks of one had been seen. So far as we could ascertain such a beast had not, within the memory of the oldest inhabitants, been heard of in



THE RHINOCEROS

this part before. We therefore hardly dared to hope that such an improbability was true and we thought there must have been some mistake. I eagerly sent for all my books from which I could gather any information about this curious genus and their habits, and did not forget Rowland Ward's useful little "Sportsmans' Handbook" which shows the vital spots of the larger mammalia. Many were the conjectures we made as to whether this stranger could really be a Great Indian Rhinoceros (*R. unicornis*) or the smaller one (*R. sondaicus*). From Kinloch's "Large Game shooting," I found it was quite feasible to bag the beast, should he really be there, by quietly following up his tracks, on a single elephant, which was all I had at my disposal.

For several days after I received the news I was engaged in my work, but we decided to devote the coming holidays to the pursuit of this prize and settled that a forest rest-house in the heart of the main reserve should be our head-quarters during the quest. We arrived there on the 23rd December and a few miles off I was shown tracks which, though several days old, at once cleared my mind of all doubt and proved that a rhinoceros had really been there.

The reserve in question, situated only a few miles south of the Nepal boundary, is a large block of some 69 square miles in extent, consisting chiefly of compact forests of *sāl* divided up by large stretches of tall grass intersected by rivers. The grass lands correspond with the area annually under water for the greater part of the four months of the rainy season. After that most of the water drains away leaving large expanses of water and marsh on the lower levels. It seemed an ideal abode for a rhinoceros and, knowing that he had been there, I felt sure he would not leave such a place of his own accord.

I had sent, beforehand, for the four best trackers to be obtained in the neighbourhood. They were *Bhurs*, a wild aboriginal tribe, who are more at home in the jungles than elsewhere, and these for several days had been roaming in pairs to try and find fresh tracks for me. They came to me on the evening of the 23rd and said they could not find any. Their task was not a very difficult one, as the whole reserve is divided up by cleared fire-lines, 50 or 100 feet wide, and by roads, some of which the animal was bound to cross; but as I was no more successful myself that day in discovering recent tracks I could not upbraid them. However, I found out they had conceived a mortal dread of the strange beast which, they declared, when it saw a man, mesmerized him and then slowly walked up to him and licked him to death with its huge tongue. Later on a forest guard came to report he had found fresh tracks in his beat. I decided to go there early next morning and gave orders to the *mahaut* to have the elephant ready. The latter, named "Gunga Pershad," is the property of the Forest Department. He is

a fine young male elephant, some 30 years old, perfectly quiet to shoot from, and as far as my experience goes, fears nothing though up to date he has not encountered a charging tiger. The *mahaut* listened to the order with a sad face and departed. Soon after, however, he re-appeared and said "Sabib ! no elephant will go within a mile of a rhinoceros." "Gunga Pershad will," said I. He answered:—"If you insist on taking him he will certainly get killed by the rhinoceros, for they are deadly enemies." I said:—"Very well, if he gets killed I will buy another one." Seeing that I was determined to go, he said no more but later on I overheard him saying to another servant:—"Does not everyone know of the Rajah who had twenty elephants all killed by one rhino?" This common belief among natives is alluded to by Kinloch and Blandford.

Now came the crux. What weapon should I shoot with? I had no heavy battery and indeed only two rifles with me; one a double-barrelled hammerless ejector No. 2 Express by Westley Richards, the other a Martini-Henri sporting carbine, taking also the M. H. R. cartridge. I remember a well-known sportsman of the Central Provinces telling me in 1890 that, if he had to shoot big game like elephant and buffalo, and if he were only allowed one rifle, he would choose a M. H. R.* This statement impressed me greatly at the time; and, profiting by it, I have been much more successful with a single M. H. R. against buffalo and bison than with heavy, double-barrelled 8, 10 or 12 bores, all of which I have tried. With the Martini-Henri, however, one soon learnt that it was no use attempting to shoot such large animals unless one had a clear shot at a vital spot. I decided to take my first shot with it; for, although my Express was a grand rifle and Westley Richards had made me some special hardened solid bullets for big animals, I had not so far tested them.

On the morning of the 24th I started on the elephant, taking the trackers with me. Having reached the spot where the forest guard had seen the tracks, we found fresh ones of that morning and our search commenced. The tracks led into tall *ratwa* grass, with a few groups of trees on the higher ground and shallow ponds on the lower. We came upon tracks in all directions which rendered the fresh ones undistinguishable. After searching about for a long time we found a place where the rhino had been lying down that morning, and fresh droppings close by, but I think the noise made by the elephant walking through the water must have alarmed him; for, though we continued searching all day we could not find him.

Next day, Christmas day, I did not go out but sent the trackers to see if there were any new tracks. They reported in

* Possibly he now believes in a .303. ? Personally, I have not had the opportunity of trying one of these small bores yet.

the evening that there were, so on the 26th morning I again started. When I arrived at the spot where the tracks were found I quietly posted three of the trackers, in different parts, in trees, who might be able to give me information in case I disturbed the rhino. The other *Bhur* I took with me on the elephant. This time, knowing the ground, I made the elephant go quietly round the water to the place where we had found he had lain down two days before, but the rhino was not there.

There was a shady clump of trees, with short grass under them, about 100 yards on, which looked a likely place, so I went on, and when half way through, I suddenly saw the legs of the rhino about 60 yards to the right. Having backed the elephant a couple of paces I saw the whole beast standing, broadside on, under the trees and obtained a steady shot with the Martini-Henri at the centre of the front right shield. I felt sure that the bullet was well placed, but the rhino, having only flinched to the shot, began going away at a slow pace. I was then most anxious lest the beast might get out of sight and re-cross into Nepal, whither I could not follow; so I ordered the *mahaut* to urge on the elephant in pursuit and I put five solid bullets out of the Express into him before he fell. On cutting him up, however, I found that the Martini bullet had gone through both lungs and heart; so the remaining bullets were unnecessary. He fell on his left side, and not in a sitting posture, as it is said they generally do.

He was indeed a grand beast and I was in luck to have secured such a prize. He turned out to be a fine specimen of *R. unicornis*; but his horn, which was much worn and knocked about, measured only $7\frac{1}{2}$ inches. Afterwards I found that a new horn had begun to be developed under the old one, and doubtless in a short time the latter would have been cast off.

Rhinoceros are, I am told, fairly plentiful in Nepal, in the *Dún* to the north of the lower range of hills, but they are strictly preserved as Royal game. Only the Maharaja shoots them; no one else apparently is allowed to pursue them. This one, I heard subsequently, was washed down the river in a flood in September, but scrambled out near the Nepal boundary. He remained just inside Nepal in the grass-lands there till the end of November, when the people began to cut the grass for thatching their huts. Then, being disturbed by them, he found his way one night across 12 miles of open cultivated country to the Government forest where he was shot.

The news of his death spread rapidly, and next day, although the nearest villages were six miles off, hundreds of natives came to see him and begged for pieces of meat; and failing that, of bone or skin. For weeks afterwards the people continued to come to my camp to see the skin and trophies, and altogether, while it was drying, I think not less than 5,000 people must have come, some of them from distances of 25 and 30 miles. Kinloch says that the meat is excellent and so it certainly proved.

TRANSFORMATION OF ALBURNUM INTO DURAMEN IN THE OAK, 269

The measurements of this rhinoceros were as follows:—

		Feet	Inches.
Length from nose to tip of tail	...	12	11
Do. of body	...	10	9
Do. of tail	...	2	2
Height at shoulder	...	5	8½
Girth of body behind shoulder	...	8	10
Do. of stomach	...	11	4½
Do. of neck	...	5	2
Do. of foreleg above knee	...	1	10
Do. of head	...	5	3½
Breadth of forehead	...	1	2
Length from toe to heel (fore-foot)	...	0	11
Breadth of fore-foot	...	0	8½
Circumference of fore-foot	...	2	6½
Length of horn	...	0	7½

F. Z. S.

Transformation of Alburnum into Duramen in the oak. *

M. E. Mer has studied the mode of formation of the duramen out of alburnum in *Quercus Robur* and *Q. pedunculata*. The duramen is characterised by a resorption of the starch in the ligneous and radial cells; by the appearance in these elements of a large quantity of tannin; by the production of thyllæ in the large vessels; and by the impregnation of tannin into the walls of all the elements, especially those of the vascular bundles. It was determined by observation and experiment that the entire disappearance of starch from the cortical region is not due to migration but to resorption, it being replaced by fresh starch which is being constantly formed in the leaves. The appearance of tannin coincides with the disappearance of the starch. The formation of thyllæ in the duramen is due to a renewal of cellular activity produced by hypernutrition. The main function of the alburnum is, therefore, to furnish a supply of nutriment for the production of the "perfect wood" (duramen).

* Journal Royal Microscopical Society. Original paper in *Ann. Sci. Nat (Bot)*.

Bursting of the mechanical ring in climbing plants.*

From the examination of a number of trees and shrubs belonging to different natural orders, Herr E. Schwabach states that a perfectly closed stereome ring in the young stem occurs only in climbing plants. As the girth increases, this mechanical ring bursts, and at the same time the adjacent parenchyme cells, rich in protoplasm, force themselves, by their turgor, into the vacancies and distend them. This takes place so quickly that it is impossible to find such a cavity, which is not filled up by meristematic tissue. The meristematic cells thus introduced thicken their walls and become transformed into stone-cells with extraordinary rapidity and thus increase the mechanical functions of the ring. The bursting usually takes place in the radial prolongation of the medullary rays, especially where the stereome ring offers the least resistance. The penetration of the parenchymatous cells, which adjoin the stereome ring, takes place on both the outer and inner sides of the ring.

Classification of Fruits. †

Signor L. Nicotra proposes several modifications in the terms at present applied to different kinds of fruit. He proposes the term *holocarp* (*olocarpio*) for an entire fruit resulting from a number of carpels, the product of each carpel being a "mericarp." The holocarp may be an *apocarp* or a *syncarp*, depending on the degree of concrescence of the carpels; but these two forms pass insensibly one into the other. According to the arrangement of the carpels into a spiral or in a whorl, a holocarp is a *helicocarp* or an *actinocarp*, and furthermore according to the position of the placentæ, it is *pleuropermic* or *antispermic*. The caryopsis differs but very slightly from the achene. The author regards the follicle as probably a primordial carpological type, from which are derived, in various directions, the legume, the single-seeded indehiscent achene, the siliqua and the various forms of capsule.

Indigo fermentation. ‡

According to Professor H. Molisch, the transformation of indican into indigo blue in *Indigofera* is not due, in the first place, to the action of bacteria ; whether within or

* Journal Royal Microscopical Society. Original paper in Bot Centralblatt

+ Journal Royal Microscopical Society. Original paper in Bull. Soc. Bot. Ital.

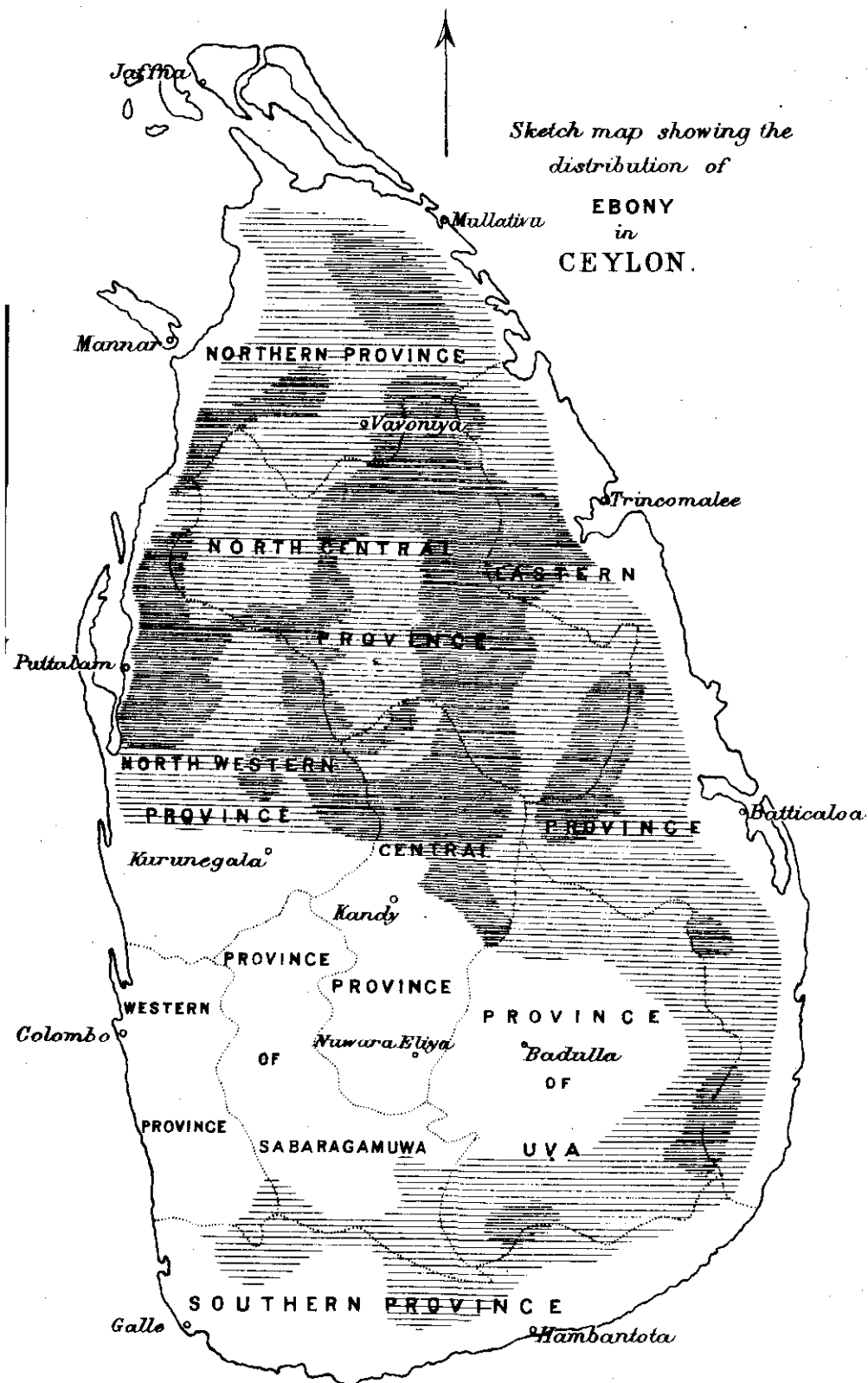
‡ Journal Royal Microscopical Society, S. B. K. Akad. Wien, Oesterr. Bot. Zeitschrift.

without the dead cell, oxygen is indispensable to the process. It is accompanied by a number of different bacteria, and not by a single species, as previously supposed, and mould-fungi are also present. In some cases (seedlings), indican is formed only in the light; in other cases both in the light and in the dark, but always more abundantly in the light. The following species, in addition to Indigofera, are named as Indigo plants:—*Echites religiosa*, *Wrightia antidysenterica*, *Crotalaria Cunninghamii*, *C. turgida* *C. incana*.

Vaccinating properties of mushroom-juice against venom. *

M. C. Phisalix has found that mushrooms contain substances having vaccinating properties against serpent venom. Some 200 experiments made with poisonous and edible mushrooms show that their juice, which contains these bodies in solution, confers immunity against venom. Injection (subcutaneous, intraperitoneal and intravenous) of small doses of the juice of *Agaricus arvensis* produces local and general reaction; of large doses, rapid death with clotting of the blood. The toxic effects of the juice, even when heated for 20 minutes to 120°, are not completely removed.

When a guinea-pig has been injected with 5 to 20 ccm. of the juice, after a few days it will resist a dose of venom fatal in 5 or 6 hours to the control-animals. This immunity may be augmented to a certain degree by increasing the number of inoculations. The immunity thus acquired lasts from 15 days to one month. The raw juice often produces necrotic effects; these are lessened by using filtered juice, and are avoided by boiling it for a few minutes. This, so far from impairing the vaccinating property, rather seems to favour it.



N.B. The best forests are indicated by denser shading.

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[No. 7.]

Ceylon Ebony.

DIOSPYROS EBENUM—Koenig.

The name Ceylon Ebony for *D. Ebenum* is not absolutely correct, for this species is found in Southern India, nor is it only Ceylon *Diospyros* which has a black heart-wood there being others such as *D. ovalifolia*, *D. crumenata*, *D. Melanoxylon* and *D. oocarpa* which furnish a certain amount of ebony. It is even not certain whether the species will not have to be subdivided into two on account of the varied arrangement of the fruit, whether solitary or in clusters in the axils of the leaves. It is however convenient for me to use this name as it is used in the timber trade, and also because my acquaintance with it is limited to Ceylon.

Habit.—Without going into botanical details it may be said that this is a large evergreen tree, attaining a girth of up to 14 feet. It has a roughish bark of a dark colour which, in exposed situations, has a greyish tinge. The leaves are also dark and appear as if sprinkled over with fine charcoal dust. Several other species of *Diospyros* possess very similar characteristics and it requires a certain amount of experience to distinguish the species, especially saplings and young trees.

Distribution.—Ebony has almost the same range of distribution as satinwood as the annexed sketch map will show, but it is found more abundantly in the intermediate zone and in the south of the island it penetrates even into the moist zone. But it is most abundant in the dry zone and the richer forests are all in the Northern half of the island, especially in the Eastern portion of the North-Central Province. It is also well represented in the Northern and North-Western Provinces.

Soil.—The best ebony is found on rocky well-drained soil. It is at times found on soil containing a larger proportion of clay than satinwood can endure but, generally speaking, it is found like satinwood on sandy loam with a good subsoil drainage. It is frequently found near watercourses, which are dry during a part of the year, but in swampy soil never. It differs in this respect from *Diospyros Embryopteris* which is frequently found near rivers, pools or tanks.

Companion species.—As I have stated before, satinwood is frequently a companion of ebony, as also *Mimusops hexandra*, *Nephelium longana*, *Gleniea zeylanica*, *Diospyros ovalifolia*, *D. crumenata*, *D. oocarpa*, *D. montana*, *Vitex altissima*, *Albizia odoratissima*, *Berrya Ammonilla* on the moister soils, and many others. I have never seen ebony growing pure and the proportion of this species to the many others is always small. In the richer forests there may be 10 to 15 trees per acre or, taking the saplings into account, perhaps 50 trees, but this percentage is high. I have only heard of one instance, in the Mannar District, where there were 40 trees (exclusive of saplings) per acre. In an enumeration survey made recently over 50 acres in a fairly rich ebony forest in the North-Western Province, 26 trees over 6 feet in girth, 65 from 4 feet 6 inches to 6 feet and 120 trees between 3 feet and 4 feet 6 inches were counted. This gives a total of 4 trees over 3 feet in girth per acre. In average ebony forest, enumeration surveys both linear and by sample area made in the Northern, Eastern and North-Western Provinces, have shown that there are generally not more than 3 to 4 trees over 9 inches in girth per acre. This is, no doubt, partly due to the extensive and wasteful fellings which were carried on for many years over the Ceylon forests, and partly to the absence of improvement fellings required for furthering the growth of the young trees and saplings.

Sylvicultural requirements.—Unlike satinwood, ebony does not require much light for its seedlings. As a rule, it will suffice to cut the underwood and to girdle here and there a low-crowned tree. But after the seedlings have established themselves it is necessary to remove the cover which is directly overhead, not more. When the trees reach their maximum height, it is time to give more room to their crowns, but until then it is best not to let in too much light. It is difficult to see how the seed gets distributed over the soil of the forest, except in hilly ground, where it rolls down the slopes, or near streams or foot paths acting as such during wet weather, and yet trees are found, as often as not, at the top of a slope although the seed is neither light nor apparently palatable to birds or mammals although it becomes a prey to weevils, which would be rather a factor in the destruction than in the distribution of the seed. The seed usually ripens before the North-Eastern monsoon, but the good seed-years are not regular

nor is the seeding equally good all over the forests at the same time. Observations taken in the forests since 1890 have not recorded a single universally good year, but the years 1891 and 1896 appear to have been the best while in 1892-93 and 1897 the seeding was fair. The good seed-years do not appear to come in any regular rotation but are dependent chiefly on rainfall at the right time. Occasionally, ebony seeds twice in the year. (*Ceylon Forester*).

Rate of growth.—There are, unfortunately, not yet sufficiently reliable data to show the rate at which this tree grows. Several sample plots have been started but they contain so few trees, sometimes not even all girth-classes being represented, that it is not possible to take the measurements as absolutely reliable. As a rule, after passing 3 ft. in girth, ebony is very slow growing, more so than satinwood. From the data which I have been able to collect the rate of growth in the forest appears to be about the following, but, as I say, the figures are very liable to correction. The present measurements seem to show that a tree reaches a girth of 18 inches at the age of 25 years, 36 inches at 75 years, 54 inches at 135 years and 6 feet in girth at the age of 200 years. On deep soil these figures are probably below the mark and the trees grow faster.

The timber.—The proportion of heart-wood to sap-wood varies a good deal. It is commonly considered that timber grown on deep soil contains a smaller proportion of heart-wood than trees growing on rocky slopes. My own experience coincides with this theory, not only as regards *D. Ebenum* but also as regards *D. Melanoxylon*. As regards the latter, I remember that small trees on the stony slopes of the Ganges division gave a far larger supply of blackwood than comparatively large trees growing on alluvial soil in the western part of the Saharanpur division. Recently, 15 trees of Ceylon ebony, varying in girth from 6 ft. to 12 ft. were measured carefully. The gross volume of these trees amounted to 1,208 cft. while the volume of blackwood was 282 cft. or less than one quarter of the volume, the proportion of heart-wood in the individual logs varying from 0.14 to 0.35. This was in good soil and measurements have yet to be made to find out the proportion of blackwood on rocky soil. As a rule, I do not think that the thickness of the sap-wood cylinder is much less than 3 inches. The largest log of ebony, which I have seen, measured 7 feet in girth after the sap-wood had been removed. Together with the sap-wood it must have been very large; for, of the 12 ft. logs mentioned above, one gave a measurement of blackwood of 5 ft. 3 in. while another measured only 4 ft. in girth after peeling. The sap-wood is very light coloured and soft. It is peeled off by means of heavy felling axes. Circular incisions are made round the log at distances of about 2 feet apart and the portions between trimmed off. It is possible to get the wood naturally peeled by leaving the logs in the forest for some years, but

timber merchants do not like these logs and consider them to be dead wood. They, therefore, fetch lower prices. The heart-wood is not necessarily black throughout. On the contrary, streaks of white or pale brown colour are not infrequent. Some forests of the island produce blacker wood than others. For example, ebony from the western side of the island is usually less streaky than that found on the east. Generally speaking, the market favours the black ebony, if it is of as good dimensions as the streaky logs, the China market especially requires the wood quite black. For cabinet work, however, especially for ornamental beading and framing, the streaky wood is in request as it is used as a substitute for calamander. As regards the comparative value of the different ebonies in India and Ceylon, it is somewhat difficult to make a comparison. *D. Ebenum* usually gives logs of larger dimensions and is on that account more valuable. In the local market, Indian ebony does not fetch as high a price as Ceylon ebony. Some years ago a local merchant imported a parcel of logs from India. The logs were of fair girth and very black, and yet they only fetched poor prices. The explanation given was, that Ceylon ebony takes a much better polish than that from India. I was not able to ascertain whether the logs referred to were *D. Melanoxylon*. If so, they were remarkably fine. Of the different ebonies which I am acquainted with, *D. Ebenum* seems to be the most close-grained. Its surface, when polished, feels more greasy to the touch than others and this, no doubt, accounts for the higher degree of polish which it can take. The weight, according to Gamble, varies from 61 to 81 lbs. per cubic foot. I have weighed carefully six well air-dried specimens from different parts of the island and found their weights to have varied from 90 lbs. to 77.7 lbs. per cft, the average being 73.9 lbs. per cft.

Market.—The prices realized for ebony in Ceylon range up usually to Rs. 180 or Rs. 185 per ton (weighed) for good lots. I have once known the price to go up to Rs. 210 per ton, but it rarely exceeds Rs. 185, and I have never known the price of first class ebony go below Rs. 150 to 160 per ton. The price not only depends on the state of the market in Europe and China but on freight available. If freight is scarce or high the price naturally goes down. I may add that it is by no means an easy matter to obtain freight for timber, especially when large consignments of tea are being sent home.

It may be of interest to Indian readers to know how the sales are conducted. All ebony, excepting branch-wood, top pieces and dead wood remaining from former fellings which are sold in the forest or at minor depôts, is sent to Colombo, where it is sorted at the Central Timber Depôt into lots, as homogeneous as possible.

[Extract from the "Ceylon Government Gazette" of September 30, 1898.]

A N auction sale of the under-mentioned ebony will be held at the Central Timber Depot, Kew road, Slave Island, on Monday, November 21st, 1898, at 2 P. M. Total quantity offered for sale : 365 logs=157 tons 3 cwt. 1 qr. 3 lb. :-

Sale of Ebony.

Lot.	No. of Logs in each Lot.	Total Weight.	Average Weight.	Average.		District in which Ebony was cut.	Soundness of Logs.	Blackness of Wood.	Whether the Logs are from Dead or Green Trees.	Weight of Log in each Lot.		Length.		No. of Logs in each Lot over 15 ft. in Length.	Price realized per ton (weighed.)
				Length.	Girth.					T. C. Q. L.	T. C. Q. L.	Ft. in.	Minimum.		
1	15	2 16 1 6	0 8 3 0	16	18	Matale	Inferior	Black	Green	0 16 2 10	0 4 0 4	17	6	5	65
2	4	0 9 1 96	0 2 1 18	14	0	do.	do.	do.	do.	0 16 2 10	0 4 0 4	17	6	5	80
3	25	0 8 2 0	0 7 2 14	14	0	do.	do.	do.	do.	0 16 2 10	0 4 0 4	17	6	5	165
4	4	1 12 1 20	0 8 0 12	13	6	Kurunegala	Inferior	do.	do.	0 10 0 20	0 3 2 16	23	0	1	95
5	12	3 13 8 0	0 6 0 14	13	6	do.	do.	do.	do.	0 10 0 20	0 3 2 16	23	0	1	165
6	17	1 4 0 0	0 8 1 20	13	6	do.	do.	do.	do.	0 10 0 20	0 3 2 16	23	0	1	90
7	2	1 13 1 6	0 16 2 17	16	6	do.	do.	do.	do.	0 10 0 20	0 3 2 16	23	0	1	100
8	2	1 13 1 6	0 16 2 17	16	6	do.	do.	do.	do.	0 10 0 20	0 3 2 16	23	0	1	135
9	1	0 8 3 17	0 8 3 17	20	0	Trincomalee	Inferior	do.	do.	0 16 0 28	0 6 3 8	24	6	10	100
10	11	5 5 1 14	0 9 2 18	20	0	do.	do.	do.	do.	0 16 0 28	0 6 3 8	24	6	10	165
11	2	0 16 2 20	0 8 1 10	11	2	do.	do.	do.	do.	0 16 0 28	0 6 3 8	24	6	10	85
12	14	8 8 2 6	0 12 0 4	21	0	do.	do.	do.	do.	0 16 0 28	0 6 3 8	24	6	10	75
13	14	8 8 2 6	0 12 0 4	21	0	do.	do.	do.	do.	0 16 0 28	0 6 3 8	24	6	10	180
14	2	1 12 3 16	0 16 1 22	12	3	do.	do.	do.	do.	0 16 0 28	0 6 3 8	24	6	10	85
15	1	0 12 2 4	0 12 2 4	14	6	do.	do.	do.	do.	0 16 0 28	0 6 3 8	24	6	10	75
16	10	5 0 0 15	0 10 0 1	14	6	do.	do.	do.	do.	0 16 0 28	0 6 3 8	24	6	10	170
17	13	4 14 3 9	0 7 1 5	12	0	do.	do.	do.	do.	0 16 0 28	0 6 3 8	24	6	10	90
18	4	0 9 0 20	0 2 1 5	12	0	do.	do.	do.	do.	0 16 0 28	0 6 3 8	24	6	10	45
19	5	0 12 3 14	0 2 2 8	12	0	do.	do.	do.	do.	0 16 0 28	0 6 3 8	24	6	10	70
20	15	6 19 2 22	0 9 1 7	13	6	do.	do.	do.	do.	0 16 0 28	0 6 3 8	24	6	10	165
21	13	4 10 3 24	0 6 8 27	13	6	do.	do.	do.	do.	0 16 0 28	0 6 3 8	24	6	10	100
22	6	2 13 1 11	0 11 1 15	12	0	do.	do.	do.	do.	0 16 0 28	0 6 3 8	24	6	10	130
23	40	23 15 1 17	0 11 1 15	12	0	do.	do.	do.	do.	0 16 0 28	0 6 3 8	24	6	10	100
24	6	2 13 1 11	0 11 1 15	12	0	do.	do.	do.	do.	0 16 0 28	0 6 3 8	24	6	10	170
25	15	7 1 2 21	0 9 1 21	14	6	do.	do.	do.	do.	0 16 0 28	0 6 3 8	24	6	10	85
26	5	2 11 3 24	0 10 1 10	13	6	do.	do.	do.	do.	0 16 0 28	0 6 3 8	24	6	10	165
27	11	4 10 1 13	0 8 0 24	13	6	do.	do.	do.	do.	0 16 0 28	0 6 3 8	24	6	10	135
28	8	2 16 2 5	0 6 7 0 7	14	6	do.	do.	do.	do.	0 16 0 28	0 6 3 8	24	6	10	70
29	14	2 18 1 15	0 4 0 19	20	0	do.	do.	do.	do.	0 16 0 28	0 6 3 8	24	6	10	180
30	26	17 8 1 15	0 13 1 16	21	0	do.	do.	do.	do.	0 16 0 28	0 6 3 8	24	6	10	165
31	14	7 2 0 17	0 10 0 17	21	0	do.	do.	do.	do.	0 16 0 28	0 6 3 8	24	6	10	100
32	3	2 13 1 6	0 17 3 2	22	0	do.	do.	do.	do.	0 16 0 28	0 6 3 8	24	6	10	90
33	1	0 17 0 24	0 17 0 24	22	0	do.	do.	do.	do.	0 16 0 28	0 6 3 8	24	6	10	105
34	3	1 18 3 12	0 12 3 23	13	6	do.	do.	do.	do.	0 16 0 28	0 6 3 8	24	6	10	150
14a	7	1 19 2 22	0 5 2 19	13	6	Kandy	Sound	do.	Green	0 11 2 16	0 4 0 16	17	0	6	

The timber may be inspected on application made to the Superintendent, Central Timber Depot, who will give any further information that may be required.
Office of the Conservator of Forests,
Colombo, September 26, 1898.

A. F. BROWN,
Conservator of Forests.

Rs. 28,008 80
Rs. 150 18
Average per ton

After the lots have been weighed and measured a notice of auction, as shown in the annexed statement (not including the last column showing prices realized at the sale), is published in the Government Gazette and in the local papers. The Government Printer furnishes the Superintendent of the Central Dépôt with a number of copies of the notice published in the Gazette, which the latter sends to the different firms in Colombo and elsewhere. The lists give all the particulars required by the firms and they are sent to the houses in Europe or China for which they wish to purchase. As the notice is published some two months before the auction, there is ample time for all the firms to make proper arrangements. The specimen given here gives the details about the last auction held in Colombo, and in the last column, the prices obtained per ton are indicated. The auction was a very successful one as the average price obtained was Rs. 150.18 per ton.

The chief markets are in England, Germany and China. As regards the last-named country the demand fell off after 1889, during which year little ebony was sold and the trade received a further shock during the China-Japan war, but it is now showing signs of reviving.

Outturn.—The number of tons of ebony sold from 1889 to 1898 (both inclusive) amounts to 2,999.72 or on an average 299.97 tons per annum. This appears to be a small outturn, but the reason for it will become apparent when I state that the average exports from 1862 to 1881 alone, to say nothing of the local sales, amounted to 22,522.5 tons or on an average 1,126 tons per annum and that in 1881 as many as 2,600 tons were exported. This appears to have been the climax and in 1888, the year before the Forest Department was organized, the exports fell to 617 tons. This may have been partly due to Mr. Vincent's spirited report on the subject, but more probably to the forests near to the export centres becoming exhausted. But the damage done to the forests was by no means confined to the amount of ebony exported. First of all the fellings were made without any consideration for sylvicultural requirements. Then, there is a very fair local trade in ebony, which is not taken into consideration in the table of exports. A lot of trees were also wasted, felled and found hollow and too far to be carted at a highly remunerative rate and they were left in the forests to rot. By no means a small proportion of the ebony sold between 1889 and 1898 consisted of logs and top pieces from former fellings and of dead trees.

Perhaps the greatest harm done to the ebony forests was caused by tapping the trees. As I have said before, the amount of heart-wood varies greatly. The fellers did not want to waste their time on trees giving a small yield of blackwood. They therefore went from tree to tree, not even sparing comparatively small ones, and with their axes cut deep notches on

different sides so as to find out how deep the heart-wood lay. In some forests, especially in those within fairly easy reach of the sea, there is hardly a tree to be found which is not thus mutilated. The marks thus made almost invariably lead to unsoundness and it is pitiable to find in forests, which have been worked many years back, hardly any but hollow trees. It is, therefore, apparent that the forests must now be worked with great leniency and, in consequence, the sales have hitherto been limited to from 3 to 400 tons per annum. In future the forests will be only worked on a possibility by area which will prevent overworking.

Uses of the wood.—In China, ebony is used chiefly for the manufacture of chopsticks and for pipes, also for carved stands for supporting vases, images, &c. In Europe it is used for turnery, cabinet work, and specially for the keys of pianos, for rulers, backs of brushes, &c. For furniture, ebony is largely used in Ceylon but it is too heavy, excepting for pieces which are either small, or such as do not require to be moved frequently. It is more suitable for in-laying, and streaky wood is used for edging panels of lighter coloured woods. Mr. H. P. C. Armitage in the "Ceylon Forester" says "that ebony shavings mixed with *Terminalia chebula*, alum and other substances boiled in water are used as a remedy for toothache, and that ebony dust and sulphur are put in dog's food as a remedy for mange."

A. F. BROUN.

The supply of Railway sleepers.

The *Indian and Eastern Engineer* of January puts forward the axiom that "it would help materially to cheapen both railway construction and maintenance if the annual yield of timber from the Himalayas could be enhanced," and it points out that the deodar sleeper is the best and also cheapest. We may, therefore, assume that the writer has in view the yield of *deodar* timber.

It is pertinently said that the *Articles* which have appeared in the *Indian Forester* give no answer to the questions whether the Himalayan forests do, or do not, contain sufficient timber to give the desired yield in sleepers; and if they do not, whether they could be further developed by careful arboriculture.

To these questions we propose to give such elaboration as may lead to the definite answers which our contemporary seeks.

In the first place the deodar, as explained by Brandis in the *Forest Flora of North-West and Central India*, "has a limited range of distribution. It is indigenous on the mountains of Afghanistan and North Baluchistan, and in the North-West Himalayas.

"No indigenous forests of it are known east of 80°, or west of 66° long."; and in the second, although its habitat ranges from 4,000 to 10,000 feet, the chief forests probably lie between 6,000 and 8,000 feet, or precisely at that elevation where villages and cultivation are chiefly located. The result of its narrow distribution is that the forests of deodar from the Alaknanda river in the east to Afghanistan are almost exclusively in Native States. The few exceptions within British territory are the forests of the Jaunsar Bawar, those of the Kulu valley, and the limited areas in the Khagan valley, of which Government owns a share only. These forests, after providing for local requirements, can yield annually one or two thousand trees only for export to the plains in the form of sleepers or otherwise. The rest of the deodar-producing tracts are situated in the different Native States extending from Tehri Garhwal in the east, to Kashmir and Afghanistan on the west; but the British Government have taken measures to insure the sound working of, and the maintenance of a permanent yield from most of these. The forests of Bashahr, Chamba, a portion of those of Tehri Garhwal, and the smaller ones of Raiengarh and Dadi have been leased and are being worked up to, but strictly within, their possible annual yields. Elsewhere in the State forests of Kashmir and the Simla Hill States, such as Jubal and Taroch, the exploitation is based on working plans and the advice of competent forest officers. So that there is in all these cases a guarantee that the forests are being worked and at the same time not over-worked, and at any time information is available as to the number of trees which can be cut during the next 20, 30 or 40 years.

Certain forests in Kashmir, the property of *Jaghirdars*, and those of Mundi and Suket have, so far as our information goes, not been brought under systematic working and from these it is probable that no sustained yield may be looked for, though they have contributed largely to the supply of sleepers in recent years.

Of the deodar forests to the west of the Khagan valley, little appears to be known either as regards their capabilities or the feasibility of working them.

The existing forests are, doubtless, capable of further development, and also of some extension; but there is the insuperable obstacle to this latter on any large scale, that the zone in which deodar thrives is also the densely-populated part of the Himalayas, and compact areas of suitable land cannot be acquired. Everything possible, where the control or influence of the Government can be exercised, is being done both to extend the area under deodar, and to increase the proportion of that valuable species in forests where it occurs mixed with other trees. There is no case for a syndicate with capital to carry on this work, since the available trees for many years to come are too few to afford continuous timber operations on a

sufficiently large scale, and no company could be floated (even if land could be acquired) to simply undertake the planting up of areas with trees which take 120—150 years to mature. The only sound plan is to exploit the forests to their utmost capability, that is, to make available the largest possible *annual* yield, based on an enumeration of growing stock ; and to improve their productive power by careful protection and plantings. A monied company would, no doubt, be very pleased to anticipate the yield of the next 40 or 50 years and to work out the whole of the marketable trees in the course of 3 or 5 years, but such a procedure would ruin the reproductive power of the forests and put an end to their permanence; for sylvicultural exigencies, equally with the necessity for providing a regular annual income to the proprietors, make it imperative that the removal of the marketable trees shall be spread over the time required for younger trees to take their place.

The results of any more rapid working would be ruined forests, a suspension of revenue and of sleeper supply, lasting for many years, and doubtful re-establishment of the forests or restoration of deodar wood supplies.

It is often stated that it is not the business of the forest officer to convert and carry to the market, or the sea-board, the timber and produce of the forests. It is argued that such work is better done by the middleman, and more cheaply carried out by private enterprise. The merchant is said to better understand the business of trade and the markets than can the Government officer; and this may often, if not always, be true; but it is usual to overlook a factor of much importance in working out timber by Government agency. The protection and management of the forests involve the up-keep of a considerable establishment, both of European controlling officers and of native executive staff: and this establishment is available at no additional outlay for the supervision and carrying out of timber works. The natural outcome is a saving of at least 25 per cent. compared with the cost of similar work done by private and independent traders. This saving has the effect of enabling timber and produce to be put on the market at a profit to the owner of the forest, whereas no private individual could afford to work it at all.

In conclusion, we would also lay stress on the short-sighted policy of the Railway authorities in from time to time combining to reduce the price of sleepers below that at which they can be delivered in quantity, or at all, from the more distant forests. Such action has a most mischievous influence and does more than anything else to check and curtail the regular supply of sleepers. If it is admitted that the deodar sleeper is the best and the cheapest, let there be an end of the struggle to purchase it at three rupees a broad gauge,

and one rupee and eight annas a metre gauge piece delivered on the railway lines, at which it is quite certain only a limited and ever-decreasing number will be worked out of the forests. Let the railway companies realize that, to stimulate the extraction of the possible yield of the forests, they must pay prices at which sleepers can, from all parts of the deodar-producing zone, be extracted at a profit; and they will not fail to obtain all that the forests can at present give, and be further instrumental, without the aid of syndicates or capitalists, in favouring the adoption of what measures are feasible for the improved and enhanced outturn of the forests.

A new species of Albizzia.

In January 1877, when I had the pleasure of visiting the Moharli reserve in Chanda, Mr. R. Thompson, then in charge of the forests in that district, drew my attention to a species of *Albizzia*, similar to *A. odoratissima*, but quite different, and afterwards sent specimens in flower.

At the time I determined, if it really turned out to be a new species, to call it *A. Thompsoni*. More than 20 years have elapsed since then, and I have only now, after an examination of the rich material at Kew, come to the conclusion, that it must be regarded as a distinct species, which I hope now to be permitted, with a few other novelties, to describe in the Journal of the Linnean Society. It is a large tree with spreading branches, attaining a girth of 6 to 7 feet. In January and February it is bare. By the end of February or in the beginning of March the first leaves appear, together with the flowers. The flowers are pale yellow, anthers pink, while *A. odoratissima* has fragrant flowers and yellow anthers, which in Chanda appear much later, towards the end of April and in the beginning of May.

Mr. Thompson informed me at the time, that he had often found it associated with *A. odoratissima* in the Moharli and other forests of the Chanda district. Its native name is Sitari, while *A. odoratissima* in that district is called Chichwa.

Young leaves and branches are softly tawny-tomentose. The leaves are larger than those of *A. odoratissima* but the leaflets are a little smaller. The chief distinguishing characters are, that the flowers are pedicelled and that the ovary and young pods are perfectly glabrous and shining dark brown. In *A. odoratissima* the flowers are sessile, the pods when young velvety, and only glabrous when full grown.

It is, however, remarkable that this species is as yet only known from the Chanda district. Of the species hitherto described, *Albizzia schimpesiana*, Oliver, of Abyssinia, resembles it most.

Perhaps the following key to the Indian species of *Albizzia* may be found useful.

- I. Pinnæ 1 or 2 pair, leaflets 1-3 pair, 3-5 in. long.
 1. *A. lucida*, Benth.
- II. Pinnæ 2 to 12 pair, leaflets $\frac{3}{4}$ in., rarely $\frac{1}{2}$ in. long and more. Midrib, if not quite in the middle, never near upper edge of leaflet.
 - (a) Flowers sessile.
 - Pinnæ 3-4 pair, leaflets 1 to 2 in. long.
 2. *A. procera*, Benth.
 - Pinnæ 3-8 pair, leaflet $\frac{3}{4}$ to 1 in. long.
 3. *A. odoratissima*, Benth.
 - (b) Flowers pedicellate.
 - Pinnæ 3-4 pair, leaflets 1 to 2 in. long, pods straw coloured.
 4. *A. Lebbeke* Benth.
 - Pinnæ 6-12 pair, leaflets $\frac{3}{4}$ in. long, pods brown, glabrous, shining.
 5. *A. Thompsoni*.
 - Pinnæ 6-12 pair, leaflets $\frac{1}{2}$ to $\frac{3}{4}$ in. long, pods straw coloured.
 6. *A. pedicellata*, Baker.
- III. Pinnæ 6 to 18 pair, leaflets less than $\frac{3}{4}$ in. long.
 - (a) Midrib near middle of leaflet, leaflets linear.
 - Pinnæ 7-12 pair, leaflets $\frac{1}{4}$ in. long, flowers very shortly pedicellate, heads funicled.
 7. *A. amara*, Boivin.
 - Pinnæ 12-20 pair, leaflets less than $\frac{1}{4}$ in. long, flowers sessile, heads paniculate.
 8. *A. myriophylla*, Benth.
 - (b) Midrib close to upper margin of leaflet.
 - Pinnæ 6-12 pair, leaflets oblong-falcate $\frac{1}{2}$ to $\frac{3}{4}$ in. long, flowers pink, 1-1 $\frac{1}{2}$ in. to extremity of stamens.
 9. *A. Julibrissin*, Durazz.
 - Pinnæ 6-15 pair, leaflets $\frac{1}{2}$ to $\frac{1}{2}$ in. long, linear-falcate, flowers $\frac{1}{2}$ to 1 in. long, stamens slightly tipped with red. Stipules large, deciduous.
 10. *A. stipulata*, Boivin.

All these are trees, except *A. myriophylla*, which Sir George King in his excellent paper "Materials for a Flora of the Malayan Peninsula," describes as an evergreen, unarmed shrub or strong climber, 15-20 ft. long when climbing, 8-12 ft. high if unsupported. In this species the base of the petiole is prolonged downwards and is hardened into a recurved almost woody hook. *A. pedicellata* is as yet known only from the Malay Peninsula.

Kurz, in his *Forest Flora of British Burma*, mentions also *A. elegans*, Kurz, and *A. Teysmanni*, Kurz. Of these I have seen no specimens. *A. elegans* was called by him, in Appendix A. List of Burman Forest trees, doubtfully, *A. lebekkoides*, Benth.

This, however, which has also been reported from Upper Burma in no way differs from *A. odoratissima*. *A. elegans* seems to stand nearest to *A. stipulata*. In Asiatic Soc. Journal, Vol. 45 II, p. 299 Kurz says: Very similar to *A. stipulata*, but a much more elegant tree. *A. Teysmanni* is near *A. procera*, but with much larger leaflets.

D. BRANDIS.

The Indian species of *Anogeissus*.

In April 1868 I found on the Pachmarhi hills a species of *Anogeissus*, which struck me as peculiar. The same species I collected afterwards in the Garhakota forests, Saugor district, in December 1876, and again on the Pachmarhis in April 1877. It reminded me of *Anogeissus acuminata*, the well known Yônbin of Burma, but the branches were stiff and not hanging over as in the Burmese tree, and the leaves were quite different, broadly elliptic, with a very short point. The flower-heads are single, as in *A. acuminata*, not in axillary racemes, as in *A. latifolia*, and instead of the small deciduous bracts of the Yônbin, the peduncles of the new species frequently bear several pairs of small leaves. In the Kew herbarium are also specimens collected by the late Mr. Dalzell in the Panch Mahals of Guzerat, and by Mr. J. F. Duthie in February 1891 on the Pachmarhis (marked by him *A. acuminata*).

And what I am disposed to regard as a variety of the same species has also been collected in Merwara by A. E. Lowrie, about 1884, and by Mr. Duthie in January 1886. These Merwara specimens have short and broad leaves, clothed with greyish velvety tomentum, and some peduncles are branched, bearing several flower-heads. The flower-heads are smaller, but the structure of flower and fruit is the same. Mr. Lowrie states, that the tree flowers from November until February, and that it goes lower down into the plains of Marwar, than the other species of the same genus.

The Indian species of *Anogeissus* I am disposed to define as follows :—

I. Persistent calyx, tube shorter than fruit.

1. *A. pendula*, Edgew., Dhao, Merwara.—A small gregarious tree, with pendulous branches, leaves turning red in January before falling. Branchlets and leaves densely clothed with short, soft, adpressed hairs. Leaves $\frac{3}{4}$ to 1 in. long, broadly lanceolate or oblanceolate, secondary nerves 5-7 pair, not prominent.

Flower-heads under $\frac{1}{2}$ in. diameter, on slender axillary peduncles $\frac{1}{2}$ to 1 in. long. The ripe fruit, with wings about as broad as long, nearly orbicular. The upper portion and the short beak hairy, the lower portion glabrous.

Rajputana and Bandelkhund, extending south to the Panch Mahals and to Nimar on the Nerbudda river. The principal forest tree in Merwara and Meywar.

II. Persistent calyx, tube longer than fruit.

2. *A. latifolia*, Wall., Dhaura, Hind. Dindaga, Kan. A large tree. Leaves $1\frac{1}{2}$ to 4 in. long, broadly elliptic, obtuse at both ends, pubescent when young, generally glabrous when full grown, petiole one-fifth the length of blade. Secondary nerves 8-14 pair. Tertiary nerves prominent on the underside of leaf, parallel and anastomosing. Flower-heads $\frac{1}{4}$ to $\frac{1}{2}$ in. diam. on short peduncles, often in axillary racemes, ripe fruit nearly glabrous, shining, with the wings almost orbicular.

Sub-Himalayan tract, from the Ravi eastward, ascending to 3,000 ft., Central India, Peninsula and Ceylon, up to 4,000 ft. on the Nilgiris. Not known from Assam and Burma.

3. *A. sericea*, Brandis, Khardi, Pachmarhi. A moderate-sized tree, branchlets and underside of leaves clothed with long silky hairs. Leaves $1-1\frac{1}{2}$ in. long, elliptic, shortly acuminate, on short petioles. Secondary nerves 4-6 pair. Flower-heads $\frac{3}{4}$ in. diam., single, on long peduncles, which frequently bear a number of leafy bracts. Fruit tomentose, with the wings broader than long, wings jagged. Calyx often persistent, at the end of the long tube.

Nagpahar in the Mandla district (R. Thompson). Common on the Pachmarhi hills at 3,000 to 4,000 ft., Garhakota, Sangor district, Panch Mahals, Gujerat. A variety with smaller greyish pubescent leaves, and smaller flower-heads ($\frac{1}{2}$ in. across), in Merwara (Lowrie).

4. *A. acuminata*, Wall. Yonbin, Burma. A large tree with pendulous branchlets. Young shoots and underside of full grown leaves soft pubescent. Leaves elliptic-lanceolate, acuminate, 1 to $2\frac{1}{2}$ in. long, on short petioles. Secondary nerves 6-8 pair, arcuate. Flower-heads on short peduncles, $\frac{1}{2}$ to $\frac{3}{4}$ in. across. Fruit with wings generally broader than long.

Ganjam, Godavery, Chanda district, Chittagong, Burma.

5. *A. phyllirecefolia* Heurck et Muell. Arg. (Flo. B. Ind. II, 451) is a variety of *A. acuminata* with narrower more glabrous leaves and smaller flower-heads, chiefly found in the dry country of the Irawaddy valley, between Prome and Mandalay, analogous to the variety, with smaller leaves, of the dry hills of Merwara.

D. BRANDIS.

Injurious Insects of Indian Forests.

BY E. P. STEBBING, F.R.S. *Indian Forest Service.*

There are probably very few foresters in India who have not at times felt the want of a book giving some information about the insects which damage our forests. Mr. Stebbing's new book has now appeared as a pioneer on this subject which when worked out exhaustively, will be a vast one. Only comparatively few of the many insects which attack forest trees have been reported as doing so, and then generally with such very meagre details and accompanied by such poor specimens, usually only one stage of the insect, that correct identification has been impossible.

The present work embodies all the information which is at present available on the subject and includes many original notes and observations by the author.

The plan followed is to describe each insect under its natural order and family in the animal kingdom, and the description usually takes the form of:—

- (1) A mention of the tree or trees attacked and the nature of the damage done.
- (2) A short life-history of the insect.
- (3) Mention of the localities from which it is reported.

The above information will all be most valuable, but a weak point seems to lie in the lack of material given to facilitate identification.

In most cases no description, however simple, of the insect has been attempted. This, we think, might at least have been done for the imago of each species which is not figured, and even where figures are given, a few notes as to the colouring, markings, &c., of the insect would have been most useful in helping to identify any particular forest pest.

The figures, again, are not altogether satisfactory. The majority, including those drawn by the author himself, leave nothing to be desired, but there are others, among which we may mention numbers 12, 27, 30, 43, 44, 46, 47 and 64, which are most indistinct. Some of these latter might in fact have been omitted without detracting from the value of the book, as it is impossible to see clearly what they are intended to represent. Having said this, we have no further fault to find.

The plan of beginning each 'family' with a list of the trees injured by its members, and the nature of each injury, is an excellent one. The index, moreover, at the end of the work, which includes the names of the trees attacked, as well as those of the insects should prove most useful. If, for instance, an unknown insect is found injuring some particular tree, say the *Khair* (*Acacia catechu*) we can run it down at once by looking out *Acacia catechu* in the index and turning up the pages referred to under that species.

With the aid of Mr. Stebbing's book it ought now to be possible, without much trouble, to find out what is known and what is not about any given forest pest, and a large amount of fresh material ought soon to be collected with the co-operation of the many Forest Officers who take an interest in the subject, when it is hoped that Mr. Stebbing will bring out a new and extended edition of his most useful work.

The Flowering of Seedlings of *Dendrocalamus strictus*.

On page 22 of the January number of this Magazine, Sir Dietrich Brandis in his "Biological Notes on Indian bamboos" described the flowering of some 2-year-old bamboo plants in the Patiala State Gardens near Kalka. Babu Birbal, Curator of the Forest School, now sends in the following account of a somewhat similar occurrence in the School Gardens.

In April 1894 seeds of *Dendrocalamus strictus*, were collected on the Rajah of Nahan's estate at Kowlagurh in the Western Dun; they were sown in boxes in May and germinated well, a portion of the plants being put out in nurseries in the garden in October. These were dug up and planted out in the rains of 1896 but, the plants being rather large, some small side-shoots with pieces of rhizome attached were left standing in the nursery where they continued to grow. In April 1899, a few of

these plants flowered, and in June they produced a crop of healthy seed, some of which was sown and has since germinated. The flowering stems were from 3 to 5 feet high.

The part of the nursery on which the bamboos flowered happens to occupy the site of an old macadamized road and the soil is consequently somewhat poor. It is to this fact, combined with the mutilation of the plants, that Babu Birbal attributes their early flowering.

The distillation of Lemongrass Oil in Travancore.

The distillation of lemongrass oil in Travancore, unhampered as it is by taxes or fees of any kind, is one of the most important modern industries of the State. Lemon grass, *Andropogon citratus*, *DC.*, in Tamil *chukku nari*, occurs all over the State except at the very highest elevations, but prefers open grass jungles in the plains and low moist valleys in the hills. Another species of grass called in Tamil *Shigum*, is also used but is not considered so good.

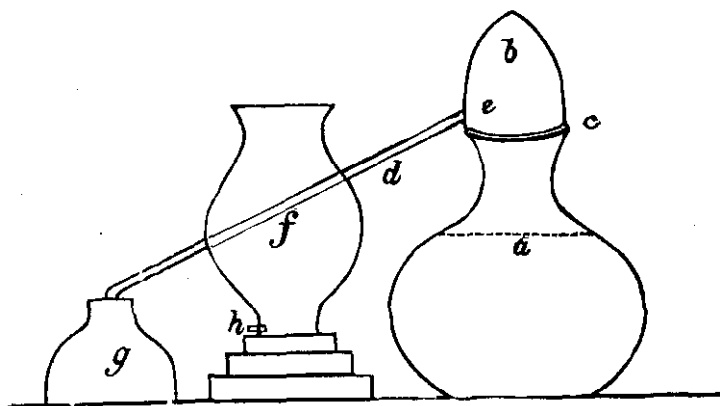
Two methods of distillation are practised, one in the Tamil or eastern part of the State, and the other in the Malayalam or western part near the sea coast.

THE TAMIL PROCESS.

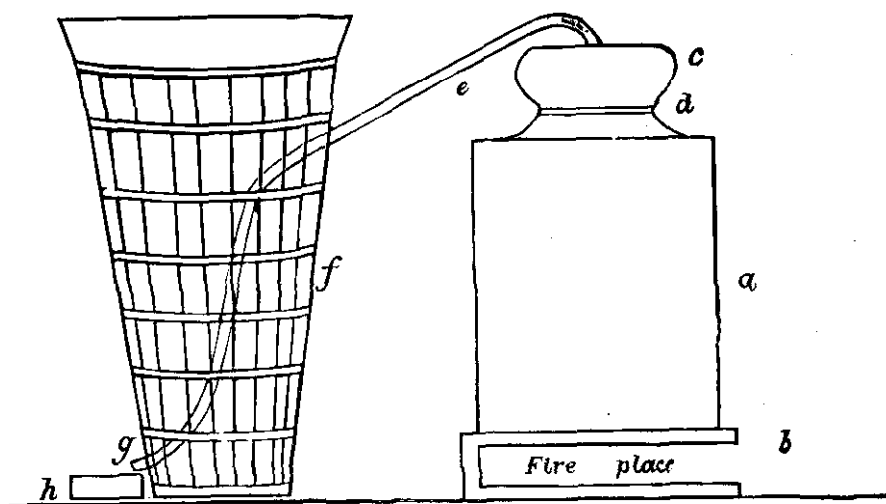
The grass is cut during the months of January and February just before the fire season commences. The tufts are cut close to the ground and the grass is chopped into pieces and dried in the sun for about 5 days. It is then put into a boiler *a*, usually made of copper and about 4 feet high. The boiler is filled to within a foot of the top and the grass pressed down tight, sufficient water being added to just cover the grass. The top is then covered with a specially prepared earthen vessel *b*, which communicates with a copper tube *d* about 3 inches in diameter, which passes through a condenser *f*, filled with cold water to the receiver *g*. The joints at *e* and *c* are made air-tight by luting with rags and clay. Fire is then applied all round the base of the boiler and as the water in the condenser becomes heated, it is drawn off through the plug *p* and fresh cold water added. Distillation is complete in 24 hours, about a pint of pure oil being obtained, and worth from 3 to 4 rupees.

THE MALAYALAM PROCESS.

On the western slopes, where the rainfall is greater, the grass reaches a height of from 5 to 7 feet and can be obtained sufficiently green and fresh for about 9 months in the year. The process of manufacture is practically the same as above, but the grass



THE TAMIL PROCESS.



THE MALAYALAM PROCESS.

is not previously dried and the tops are rejected as useless. The boiler and condenser are also somewhat different ; the former is made of copper with an earthen dome and the latter is a copper tube passing through a tall wooden bucket. Each boiling yields a quart of oil worth about Rs. 3 in the bazaar.

T. C. LEGGE.

The propagation of the common male Bamboo by cuttings in the Pinjaur-Patiala forest nurseries.

The following is one of the methods of propagating bamboos for covering the bare Siwalik hills in Patiala State, which has been tried with success :—

We selected sound and healthy male bamboo (*Dendrocalamus strictus*) culms, 3 to 5 years old, from healthy clumps of natural bamboo growing on hot and dry hills of from 2,000 to 2,500 feet elevation. These culms were divided into cuttings (what we term Puchhi) each cutting containing 2 nodes with parts of internodes at either end. These cuttings were planted between the 15th January and the 15th February 1896, in nursery beds and, as an experiment, the beds were prepared in two ways, to find out which would suit the purpose best.

- (a) Beds sunk in the ground so that they could be flooded with water to a depth of 3 inches and—
- (b) Beds with alternate ridges and trenches, the ridges being a foot-and-a-half wide and raised 9 inches above the level of the ground, and the trenches 9 inches deep and one foot wide.

The soil of the nurseries was composed of rich friable loam to which was added a large proportion of leaf mould and stable manure. The latter was specially added to give a certain amount of bottom heat and to cause the cuttings to strike readily. The cuttings in the level beds were put in standing upright with one-half buried in the ground, while those in the trenched beds were put in slanting, two-thirds being buried in the ridges in such a way that the lower end of the cuttings reached a little below the water level in the trenches.

The beds were flooded twice every week and by the middle of March the cuttings commenced to shoot, when the supply of water was moderated, but during the months of May and June (the hottest months) watering was continued every second day till the rains set in.

The cuttings all sent out 1 to 3 shoots, except a very few, about 5 per cent., which had been cut from the topmost part of the culms. During the first rains these shoots grew 3 feet in height, but were like whips bearing leaves.

The young plants were left undisturbed in the nurseries till next January (1897) when they were transplanted, with balls of earth, into bamboo baskets (gumlas) in which they were kept till the middle of July.

During this period the plants made very little progress, in fact some of the shoots died down, but they were replaced by new ones.

During the rains of 1897 the plants, with the baskets attached, were planted out at their permanent destination in the Siwaliks. They made good progress at first, but during the hot weather of 1898 about half of them died of draught.

SUNDER LAL PATHAK

Gum Kino.

The following notes on the collection of gum kino from *Pterocarpus marsupium* by departmental agency in the forests of North Malabar, are contributed by Forest Ranger A. R. Rama Rao.

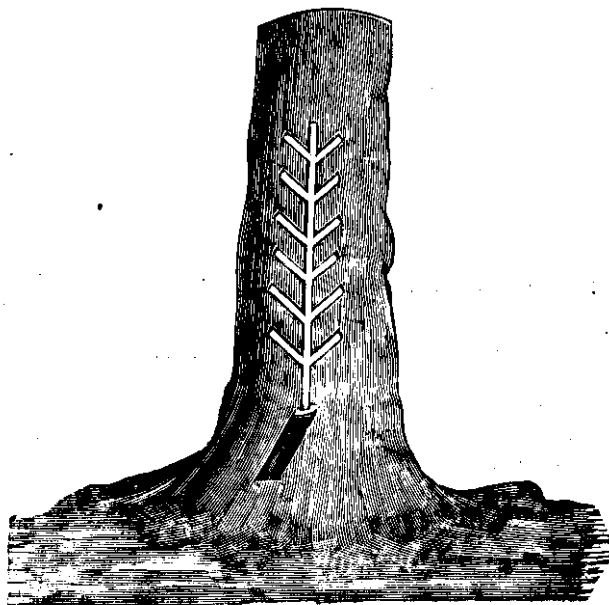
The method of tapping the trees is as follows: incisions about one inch wide are made in the bark of the tree as shown in the accompanying wood cut, the vertical incision being about 6 feet long, and the side ones 9 inches long and 9 inches apart, and at the bottom of the cut is placed a bamboo tube to receive the gum. Only trees 6 feet in girth and above are allowed to be tapped and they may be only tapped on one side, unless they are over 8 feet in girth. It is proposed, however, in future to increase the length of the incision to 12 feet.

The gum begins to flow at once and is generally all run out in about 12 hours. The gum collected in the tubes is taken to the Range Office and poured into tins, which are then taken to Manantoddy and emptied through strainers into a wooden storing tank capable of holding about 80 cubic feet.

Drying the gum by artificial heat or by exposure to the sun was found to depreciate its value, and it is now carried out in a wooden shed with a corrugated iron roof. The shed contains 2 stands of wooden shelves closed in with muslin screens to prevent the access of dust, and on the shelves are placed shallow tin trays, each $2\frac{1}{2}$ feet long by 2 feet wide and about $\frac{1}{2}$ inch deep. The liquid gum is strained for a second time and poured into the trays to a depth of about $\frac{1}{2}$ inch. Drying lasts about a fortnight in the dry weather and 3 to 4 weeks in the rains. Each filling of the trays takes about 5 cubic feet of liquid gum which when dried gives 125 lbs. of kino. The trays can be filled 16 times in the year so the total amount turned out is 2,000 lbs a year. The dried gum is packed for export in lead-lined cases, each case containing 40 lbs. of gum.

The best time for tapping the trees is said to be from October to March when the trees are in flower, but the information on this point does not seem to be very definite. The tapping should be done late in the afternoon and the tubes removed early the following morning to avoid loss caused by the gum drying on the tree or in the tube. Gum can be obtained from trees of all sizes, but that from trees about 6 feet in girth is said to be the best. Trees of larger size give a smaller yield and the gum from smaller trees is lighter in weight, a fluid ounce of gum from trees below 3 feet in girth weighing 2.7 tolas, from trees 3 to $3\frac{1}{2}$ feet 2.8 tolas, from trees $3\frac{1}{2}$ to 4 feet 3 tolas, from trees 4 to $4\frac{1}{2}$ feet 3.1 tolas and from trees 5 feet and upwards in girth 3.2 tolas. A tree of 6 feet girth yields about 3lbs. weight of liquid gum or 1lb. of dry gum, and it is estimated that the trees might be tapped on alternate sides once in 5 years. The price of the gum which was 8 annas a pound in 1895, has now risen to Rs. 2 a lb. and there seems to be every prospect of a further rise.

The gum is generally collected by Kurumbers, the hill tribe of Malabar, who are paid according to the quantity supplied. They occasionally attempt to adulterate it with water, but the fraud can easily be detected, as if allowed to stand for a few days, the gum separates from the water. Adding water discolours the gum and destroys its keeping qualities.



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A method for introducing conifers into beech forest; its adaptability to the introduction of teak into bamboo forest.

In the course of a tour in the Black forest last year, I was much interested in the method very successfully adopted by Herr Oberförster Diesslin to introduce a mixture of firs in beech forest in the town forest of Schönanau, a method which we Indian foresters would do well to keep in view in regard to the introduction of teak into bamboo forest.

The Schönanau forest is situated on steep slopes with westerly and north-westerly aspects, between altitudes of 1,600 and 3,600 feet above sea level, draining into the Wiese (a river running southerly into the Rhine) on which lies the town of Schönanau. Except quite the upper portion which is on gneiss with a gravelly soil, the whole of the area is on 'culm' a rock belonging to the lower coal measures giving a deep, moderately-stiff loam, an excellent forest soil.

The forest is composed largely of beech in the lower portion, beech with a sprinkling of silver fir in the middle portion, and of spruce and beech with some silver fir in the upper.

The problem to be solved was how to introduce the more valuable conifers in the portions where the beech largely predominates? Herr Diesslin has solved the problem in a masterly way. His procedure differs with the composition of the forest, but in both the principle is the same, namely, to keep the mass of the beech forest in full canopy, while portions of it are treated *here and there*.

There are two procedures: (1) where there is already a sprinkling of conifers in the crop, and (2) where it is composed of pure or almost pure beech.

(1) In portions of the forest containing a fair sprinkling of conifers mixed with the beech, several beech trees are cut out round each conifer, the rest of the beech forest being kept dark. The result is usually a good crop of conifer seedlings round

each tree treated. When these have established themselves, the clearing is somewhat enlarged and a new crop of conifer seedlings results, more or less mixed with beech which is kept within bounds by weeding. By this means groups of silver fir and spruce are obtained at various points in the wood where formerly there were only individual trees. If there are sufficient of such points of regeneration, nothing more is required than to regenerate the intervals naturally with beech and finally plant blanks with spruce.

(2) Where the crop is pure beech, or nearly so, the procedure is to clear spaces of about $\frac{1}{4}$ acre here and there in the wood, leaving the rest dark, and to plant up these spaces with spruce. As soon as the plants are well established the spaces are extended by clearing all round perhaps another $\frac{1}{4}$ acre, and planting up and this may be repeated a third time. Beech plants which introduce themselves have to be kept down by weeding. When the planted spaces are sufficiently large the rest of the wood is naturally regenerated with beech, as in the first case. The result of both procedures is the creation of a number of islands of conifers in the sea of beech. Regeneration of the wood by this method takes a comparatively short time, *i. e.*, from 20 to 25 years. It may be mentioned that Herr Diesslin believes in letting in a good lot of light round the conifers in order to bring the soil into a fit condition for germination, *i. e.*, with a thin covering of grass over it, he is thus enabled to cut away the beech freely round the conifer seed-bearers, thereby reducing the beech regeneration and hastening the result in view.

It appears to me that both procedures are practicable for the introduction of teak into bamboo forest in Burma and India where teak can be profitably grown. The first procedure would be carried out by cutting out bamboos round teak seed-bearers, but it will be necessary to lop and heap the debris of the culms over the stumps and thoroughly burn them in order to kill the roots of the bamboo, otherwise fresh shoots will appear, which will rapidly increase in size and soon again cover the ground. It will also be advisable, in order not to lose time, to dibble in teak seed at 5ft. by 5ft. in the clearing. The cost of clearing and subsequent weeding would, no doubt, be considerable; and with our present large divisions in Burma, the operation could, I think, be extended over an area of more than 200 acres a year in each division, but the resulting gain to the forest would, I think, be well worth the expense and trouble.

The second procedure is somewhat analogous to our taungya plantations in Burma and we cannot have a better method of introducing teak where it is absent, or nearly so. But the clearings can be made somewhat larger in bamboo forest than they can in beech as there is not so much fear of the effects

of wind. There are large areas of bamboo forest in Burma and India where teak can be profitably grown, and it would be a good thing to draw up, in consultation with the taungya cutters, a rough plan for making taungyas in each forest. I notice in para. 57 of the Annual Report of the Pegu Circle for 1897-98 it is stated that "the task of weeding taungya plantations has grown most burdensome." It has no doubt increased inconveniently of late years in that circle, but this is partly owing to the system that has been in vogue of weeding each plantation every other year and continuing these weedings till long after they were really necessary or useful. With a rational system of weeding, *i.e.*, thorough weeding for the first 2 or 3 years after the plantation is taken over, and an occasional weeding afterwards, I do not think anything would be required after the age of 8 years, except to cut out bamboos at gradually lengthening intervals. It is of great importance to encourage the growth in plantations of teak of an understory of other species to cover the ground. This object is defeated by the system of frequent weedings carried on till too late an age. I saw many plantations in Pegu where the frequent weedings have almost exterminated the accessory species, and very little is left under the teak except grass and useless weeds. The establishment of an understory and its subsequent control is not an easy business, but it is an important matter and I do not think it has hitherto received the attention which it deserves.

The results of the latest attempts to introduce teak into bamboo-flowered forest as reported in para. 58 of the Pegu Report, are quite what I expected, and show that very little good can be done by general sowings in such forest. I believe that the only rational way is to introduce it gradually by the methods above alluded to.

I am glad to see it stated in the Report that the 6ft. by 6ft. planting is recognised to be better than the 9ft. by 4ft. No doubt it is. You get more regular plants and suppress the weeds sooner.

F. B. DICKINSON.

One of Nature's Coppices.

In the north-east corner of the North-West Provinces in the Pilibhit district, and about 20 miles from the base of the Himalya, there is a nearly pure sâl (*Shorea robusta*) reserved forest covering 150 square miles which, on examination, will be found to consist almost entirely of coppice shoots. This natural

coppice is chiefly due to the physical properties of the rock (geologically speaking). Well-sinkings show that this is a light, porous sand of a moderate depth only, followed by an impermeable stratum of clay, so that water lies at but a short distance below the surface of the ground, usually from 10 to 20 feet. The sand being so porous and water so close to the surface, night radiation is excessive. The consequences are, severe frosts in the cold season and cool nights in the hot. December, January and February are the coldest months, their mean temperature being 60°. At this season night frosts are not unfrequent, as much as 10° of frost being occasionally registered. After such a frost the forest has all the appearance of having been the scene of a jungle fire. All leaves exposed to radiation up to a height of 10 to 15 feet have been shrivelled up and browned. Some sâl trees 50 feet high in exposed situations occasionally have every leaf killed. Young coppice shoots and seedlings, not above the frost level, are for the most part killed down to the ground and all the tender lower shoots of the year on the older trees are also killed.

Sâl is a gregarious tree, attaining under ordinary circumstances, a height of 90 feet and a girth of 6 to 8 feet. It belongs to the tropical family of *Dipterocarpeæ* and is its most northerly representative; hence its great sensitiveness to cold. To thrive, it demands a well-drained soil and we find magnificent forests of it 20 miles to the north of Pilibhit along the foot of the Himalaya in the Kumaun Bhábar, where the soil consists of vast deposits of sandy silt of great depth mixed with boulders from the mountains, through which water percolates freely.

In Pilibhit the sâl is outside its favourite habitat, existing as it were on sufferance, and it is only owing to its great coppicing powers that the species has succeeded in maintaining its ground. The whole forest looks dwarfed and composed of pigmy trees. Sâl of corresponding girths are only one-third or one-fourth the height of the Kumaun trees and their flattened crowns indicate that their upward growth has been arrested. The inferior quality of these trees is further shown by their contorted stems, sâl under favourable circumstances growing as straight as the larch. A considerable quantity of grass is scattered throughout the forest and the sâl leaves all fall in February and March, so that when the jungle fires occur from March to June, the dry grass and leaves furnish material in abundance for feeding the flames. These fires kill down to the ground nearly all the young seedlings and even saplings. The saplings which are not killed have their leading shoots destroyed and this too is the fate of the tender young shoots of the larger trees.

The rains begin towards the end of June and last until the end of September. During this period coppice shoots are sent

up from the stools of the seedlings and saplings which have been burnt. Some new seedlings spring up from the sâl seed which is shed at the beginning of the rains. Many of these rot in the water-logged depressions and others survive to be killed down to the ground later on by frost or fire. On the higher ground the sâl coppice shoots which spring up annually get stronger and stronger as their underground stems increase in size and can supply them with more nourishment, until they reach above the ordinary frost limit, or their numbers, by killing out the grass, reduce the violence of the annual fires. They then survive these two enemies, especially when favored by one or two mild winters or a wet hot season or two when the forest escapes being burnt, and gradually form into the dwarf-like trees, of which the forest is mainly composed.

One of the most characteristic features of the jungle are the large savannahs filled with grass and coppice-shoots of sâl which are killed down yearly and never grow up into saplings. These savannahs resemble large islands of grass in the midst of the surrounding forest. Many of them cover hundreds of acres and are such a feature of the jungle that the natives give them a special name, '*chandars*.' These *chandars* are usually situated in slight depressions, so slight indeed as to be often imperceptible to the eye and only to be detected by levelling. The ground is thus more or less water-logged during the rains, the fires are fiercer in the hot season owing to the quantity of grass, and the frosts severer during the cold weather from the absence of high cover.

Thus water, frost and fires combine to prevent the sâl from growing up and forming a forest. The unfortunate tree has hardly a minute's breathing time, contending against frost from December to February, against fire from March to June, and against swamps from July to September. To cap all these ills there are numerous village cattle (about one to the acre) which graze in the forests all the year round. Luckily they do not eat sâl but they seriously injure reproduction by treading down seedlings and young coppice shoots. It is thus only owing to its marvellous coppicing powers that the sâl has been able to maintain itself above ground in the shape of annual coppice shoots. If we dig up one of these young shoots we find it proceeds from a curious large gnarled underground stem of great age.

The Topla forest in the Balaghat district of the Central Provinces is a further striking example of the difficult struggle for existence which the sâl has to maintain in a region of frost. Topla is one of the high plateaux so characteristic of these provinces, its altitude being from 2,000 to 2,500 feet. Frosts are often severe from December to February, and their effects on the vegetation up the principal valleys are most marked. Thus, bordering the streams themselves, along the low lying, occasionally swampy ground, we find belts of grass followed by belts of low

sâl coppice shoots precisely similar to the 'chandars' of Pilibhit. The 'chandars' are in their turn succeeded by a belt which resembles a hop-garden in Kent more than anything else. The trees here are mostly saplings and fairly straight. Their lateral branches, however, seem to be killed off close to the trunk by frost but shoot out again yearly so that each trunk is covered with thick clusters of small branches all the way up. Many of the tops are also killed by frost. Finally, on the higher ground where the frost is much less severe, the hop zone is succeeded by true high forest.

In the 'chandars' and perhaps to a less extent in Topla, a curious feature in the flora is the number of dwarf species. The chief points to be noticed in these species are the enormous development of their underground stems or rhizomes, their close relation to the tree species of various families growing in the same district in more favourable localities, and their flowering in the hot season usually after the annual fires have run through the forest. In fact they are all examples of annual coppicing by nature, the underground stems only being perennial, sending up shoots yearly after the fires. The following are the most noteworthy of these dwarf species, parts of the description being taken from Brandis and Hooker.

Grewia sapida and *Grewia scabrophylla*.—The *Grewias* are mostly trees and shrubs and belong to the Tiliaceæ. The species are very numerous and difficult to define, as they are so variable and their characters tend to run into each other. Being so changeable it is easy to imagine one or more species of this genus accommodating themselves to frost and fires and thus gradually evolving new species. Our two dwarf species are small undershrubs, with short, thick, woody, underground stems which throw up annually a number of herbaceous shoots seldom more than a few feet high. These, after bearing leaves, flowers and fruit are generally burnt down by the jungle fires of the hot season. Their fruit is an edible drupe, the seed being enclosed in a hard stone, which prevents its destruction by the fires. There are also at least three species of tree *Grewias* found in Pilibhit.

Ochna pumila occurs chiefly in sâl tracts. It has a perennial underground stem, throwing up annually, after the jungle fires, a number of sub-herbaceous stems up to 2 feet high, bearing flowers in April and May. It much resembles *Ochna squarrosa*, a small tree occurring a little further east in Bengal where *O. pumila* is also found.

Olax nana is another of those odd dwarf plants which, like the preceding, appear never to form a trunk but only a contracted stock from which the shoots originate every year and are destroyed by fire, frost, cattle, etc. *Olax scandens*, a stout climber, occurs in neighbouring forests, whilst the half-dozen remaining species found in India are all trees.

Erythrina resupinata belongs to the *Leguminosæ*. From its thick, perennial, underground root-stock there springs up in March and April short racemes of large, bright, scarlet flowers, resembling those of their near relation *E. suberosa* the Indian Coral tree, which occurs in the same forest. The flowers seem to spring out of the ground like a ground orchid and it is only after flowering that the short, herbaceous, heavy stem appears.

Combretum nanum is a decumbent, low shrub with a thick, woody, prostrate stem. It is a good instance of those dwarf plants which have so well accommodated themselves to their surroundings and is burnt down annually by the forest fires. It forms a regular fringe to the sâl forest besides appearing in the 'chandars'. It is in this fringe that the heaviest grazing occurs and *C. nanum* withstands cattle even better than the sâl does. Nearly 20 species of *Combretum* occur in India, most of them being large shrubs.

Careya herbacea is annually burnt down. The root-stock is perennial and woody and the leafy flowering shoots about half-a-foot long. The large, beautiful pink flowers and big green globose fruit, 3 inches across, closely resemble those of *Careya arborea*, a large tree found in the neighbouring high forest.

Premna herbacea has a similar woody, perennial underground stem. There are over 30 species of *Premna* in India and all of them are trees or shrubs except *P. herbacea* and *P. macrophylla* which takes the place of the former in Burma.

Euphorbia fusiformis has an underground stem exactly like a large carrot and bears on the top, after the jungle fires have cleared the ground, a small tuft of flowering stems, only an inch or two high. It would be impossible for this species to exist in its present form were it not for the jungle fires, as its small tuft of flowers would be completely smothered in the long herbage.

Phoenix acaulis.—A dwarf palm found scattered throughout the 'chandars' and in other portions of the forest most exposed to fire and frost.

The above are the most conspicuous examples of dwarf species occurring in the Pilibhit and Topla forests, but the list is by no means an exhaustive one. Is it not possible that they have been gradually evolved from allied tree species which, owing to an unfavourable combination of climatic causes, have been unable to maintain themselves in their original form?

N. HEARLE.

Mr. Nisbet's note on Improvement fellings for the benefit of Teak in Burma.

In Mr. Nisbet's note on Improvement fellings he says that the whole of his suggestions are based on the understanding that such improvement operations shall only take place in areas protected from fire. Before, therefore, proceeding to discuss his suggestions, it will be as well to enquire what is the extent of the fire-protected forests and what proportion they bear to the whole area of reserves.

The last published Annual Report (1897-98) gives the following figures :—

Circle.	Total area of reserves. Square miles.	Area attempted to be protected. Square miles.	Cost per square mile. Rs.	Proportion of area attempted to be protected to total area.
Tenasserim ...	4,137	582	43	13%
Pegu ...	3,236	502	53	15%
Eastern ...	2,658	428	20	16%
Western ...	4,676	488	13	10%
Total ...	14,707	1,980	31	13%

That is, there are still some 12,720 square miles of reserves in regard to which no attempt has been made to exclude fire; and matters are really not so favourable as would appear from these figures, for there is strong reason to believe that, with the exception of some comparatively small areas, the forests shown as fire-protected in Upper Burma are not protected by any special means and only escape burning so long as there are no accidents and the people in the vicinity obey the rules in regard to firing forests; consequently the area for which adequate means of protection are provided may be taken as being nearer 8 than 13 per cent of the whole. Under these circumstances it appears to me that Mr. Nisbet's proposals, even if otherwise desirable, are decidedly premature, and that the first duty of the Burma Forest Department is to increase its area of fire-protection.

But to return to the subject of improvement fellings. Experimental operations of this kind have been carried out in Burma at intervals for the last 30 years or so, and the experience so far gained, both in this respect and the cognate matters of teak taungyas and the treatment of flowered bamboo areas, was recorded in various notes printed in 1893.* I shall therefore only deal with the subject very briefly.

*Works of Improvement, by G. Q. Corbett.
Taungya Plantations, by P. J. Carter,
Regeneration of teak in areas of flowered bamboo, by P. J. Carter
and J. W. Oliver.

For the purpose of this discussion the teak-producing forests of Burma may be divided into three classes :—

- (1) Mixed deciduous forests without bamboo undergrowth.
- (2) Mixed deciduous forests with a more or less dense undergrowth of bamboos.
- (3) Evergreen forests.

In the first of these, improvement fellings, whether in the form of seed-fellings or fellings for the purpose of giving room to existing seedlings and young trees, can be made with the greatest advantage. The older teak dibblings in the Kangyi reserve mentioned in para 58 of the Pegu Circle Conservator's report for 1897-98 are a good example of this kind of work, though it is a mistake to suppose that they have never been weeded. This class of forest is, however, very limited in extent, and forms but a trifling proportion of the total area of reserves.

In deciduous forests with bamboos, which form the main bulk of the reserves, improvement fellings (of trees) are as a rule of but little value unless carried out, either immediately before or within a few years after the flowering of bamboos. At other times the benefit caused by the removal of trees from the upper story is mainly monopolized by the bamboos, which are thereby induced to grow all the more rampantly, and little advantage accrues to the teak plants, unless they happen to have their heads above the bamboos. Moreover, the removal of the trees often takes away the side support from the bamboos and causes them to fall over, bringing with them any dominating teak saplings and more effectually suppressing the seedlings beneath them. Cutting back the bamboos themselves is only effective when the operation can be repeated every year, or at very frequent intervals, until either the bamboos flower and die or the teak poles grow beyond the reach of the bamboos. If carried out in this way the results are very good, but the operation is rather a costly one and could not be carried out on the scale proposed by Mr. Nisbet. Successful clearances of patches of bamboo jungle combined with teak sowings have also been made, but their cost has proved prohibitive. On areas over which bamboos have flowered and teak reproduction has taken place, improvement felling may be decidedly beneficial, but the number of trees which should be removed is small as the tree cover is, as a rule, very light, and it is for various reasons better in such cases to wait until teak reproduction is assured than to carry out the fellings in advance.

I do not here propose going into the question of the treatment of forests when a general flowering of bamboos takes place, but would merely remark that, as a rule, when there is a sufficiency of teak seed-bearers, we shall not go far wrong if we leave the forest alone and let it burn every year until the dead

culms have been got rid of, as there is no doubt that the splendid reproduction of teak in parts of the Ruby Mines, Katha and Bhamo Divisions, have originated in this way, as well as that in the unprotected parts of the Bwet forest in Prome where the bamboo flowered in 1878.

Teak in evergreen forest occurs to a small extent in Tennasserim, and to a very large extent in the northern part of Upper Burma. The regeneration of teak in such forests is a problem which has not, as far as I know, as yet been solved. Improvement fellings seem indicated, but to be effective, their cost would be very heavy owing to the dense evergreen undergrowth which would have to be removed and kept down.

There is an inherent drawback to any system of improvement fellings on a large scale, which Mr. Nisbet appears to have overlooked. As he himself points out, all the more valuable hard-wooded trees can easily be killed by girdling, whereas the soft-wooded, useless kinds must either be felled outright or else repeatedly girdled. The former is expensive and often, for various reasons, inadvisable; the latter is impracticable, except in the case of operations on a small scale. The almost certain result, therefore, of improvement fellings carried out in the manner suggested by Mr. Nisbet, would be the ultimate extinction of most of the better class of trees other than teak, while the proportion of useless ones would remain undiminished, a result by no means desirable. Improvement felling is, in my opinion, a very delicate operation and should only be carried out under careful supervision. These remarks, of course, do not apply to climber-cutting, which is at all times useful.

There has lately been a reaction in Burma against taungya plantations, which have come in for a good deal of unmerited abuse. This is perhaps partly due to the fact that they have increased to such an extent that their up-keep has become burdensome and almost beyond the present resources of the department. The original idea of teak taungyas, as I always understood it, was to introduce on areas of old taungya cultivation, or in forest devoid of teak, a new growth which would mainly consist of groups of teak growing on the plots most suitable to that species, with mixed forest in between. It was, I think, never intended to establish groves of unmixed teak; for, although the whole area was usually sown or planted, it was considered that nature and the carelessness of the cultivators would ensure that the result would take the form of groups of teak. Gradually, however, Forest Officers became more exacting, and their endeavours to have the whole of the cultivated areas as well stocked as possible have added a good deal to the burden of weeding.

But, after all, the cost of weeding, cleaning or thinning plantations does not, as a rule, amount to more than Rs. 1/8 per acre, at each operation, which is what Mr. Nisbet would spend on his improvement fellings, and the burden is as nothing

compared to the latter. Surely, also, it is more profitable to spend Rs. 1-8 an acre on areas stocked with at least 600 plants to the acre, of which at least 60 may be expected to become marketable trees, than to spend the like on equal areas which do not contain more than 3 trees and seedlings to the acre on the whole, or 36 (including suppressed and unsound) to the acre in the very best localities.

Another charge brought against teak taungyas is that, valuable forest is often destroyed to make room for them. This, no doubt, has sometimes happened, but I think the damage has been exaggerated. As a rule the areas selected have been under ya cultivation some 15 to 30 years previously, and the forest cleared away consists mainly of bamboos and coppice poles, teak among others, with a few old trees, badly damaged by fire and half dead, and some seedlings, the latter mostly suppressed by the bamboos. The effect of clearing such an area is that the teak coppice poles and seedlings, which have been cut flush with the ground, start into vigorous growth, and a casual observer inspecting the ground would at once assume that valuable forest had been cut down, whereas, as a matter of fact, the trees removed may have been such as would never have grown into marketable timber. Mistakes have, I admit, been made, but I think in many cases the Range officer has been unjustly blamed.

It is quite probable that by this time most of the suitable areas in Lower Burma have been planted up, and a curtailment of taungya operations in that part of the province seems inevitable, but I would strongly deprecate a complete abandonment of the system, especially in Upper Burma. The taungya system properly carried out is admittedly the best and cheapest means of establishing plantations. It has been of immense benefit in Lower Burma in affording lucrative employment to the jungle people, thereby reconciling them to the restrictions of the forest rules, and in many cases enabling them to buy cattle and take to permanent cultivation in the plains, which alone is an enormous gain, as every taungya cutter the less means so much more forest saved to the country. It may at any time become expedient to introduce teak taungyas among the hill people in Upper Burma, and for this reason I consider it desirable that a small area should every year be cultivated in each division in order that local officers may become familiar with the system.

J. W. O.

22nd July 1899.

Notes on Sal Forests.

Under the above title a pamphlet by Mr. Eardley-Wilmot is printed with the June number of the Indian Forester. The author presented me with a copy some months ago, and this led me to pay more particular attention to the subject of sál reproduction. I take this opportunity of recording a few observations on coppice growth of sál.

The Charda forest in the Bahraich Division is a good example of a forest which has grown up principally from coppice shoots. Up to 1866 the forest was in the possession of the Rajah of Balrampur, and had been repeatedly cut over. Fire-protection was started in 1872, and closure to grazing in 1885, with a further extension in the same direction in 1895. Systematic fellings were first started in 1888, a system of coppice-fellings in strips being adopted. In 1890 this was altered to coppice with standards, and this method has been continued up to date under the present working plan, which came into force in 1895. The rotation is 20 years.

When examining the felled areas in May last, I devoted particular attention to two points; viz., the limit of size of stools capable of producing coppice shoots freely, and the extent to which the reproduction was due to root-suckers. I propose to give a few notes on each of these matters.

Stools above 3 feet 6 inches in girth I found rarely produce shoots in abundance; stools of smaller size generally do so. I have seen shoots on stumps 4 feet in girth, but this is not common. Fellings in coupe IV were carried out from December to March last, and walking through the area towards the end of May, I rarely came across a stump less than 3 feet 6 inches in girth, around the edge of which shoots were not appearing. Larger stumps, more often than not, showed no signs of life.

As an example of difference in vitality I may give the following instance:—On 29th May I counted 115 clumps of shoots on a square chain of the area felled in February and March. This represented 1,150 to the acre only 2½ months after felling. A year hence the number will probably be much greater.

Twenty average clumps were dug up and measured as follows:—

No. of clump.	Girth of cut stool.		Height of tallest shoots.		No. of shoots in the clump.	No. of clumps.	Girth of stool.		Height of tallest shoots.		No. of shoots in the clump.
	ft.	in.	ft.	in.			ft.	in.	ft.	in.	
1	4	6	0	8	10	11	1	2	4	3	9
2	4	0	0	6	3	12	1	0	4	8	4
3	3	5	2	0	1	13	1	0	1	9	1
4	3	2	4	3	13	14	0	11	2	11	10
5	2	2	3	5	10	15	0	9	2	8	5
6	2	0	2	9	4	16	0	9	2	3	5
7	1	8	2	3	6	17	0	8	3	4	4
8	1	8	3	0	6	18	0	8	1	5	4
9	1	3	3	10	9	19	0	6	2	10	2
10	1	2	4	3	6	20	0	6	1	9	6

The measurements were not sufficiently extended to serve as the basis of any argument, as to the comparative vitality of stools of different sizes. I merely record them with a view to showing how healthy and promising the forest is. A growth of 4 feet 8 inches in about 10 weeks compares favourably, I should say, with growth in any other forest.

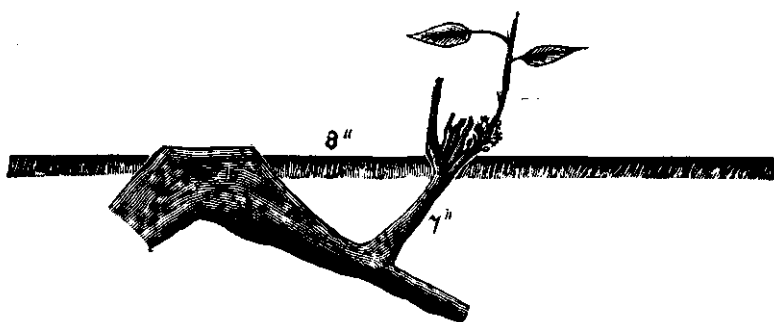
On the subject of root-suckers the author of the "Notes" states on page 9:—

"In tracing the root system of sâl coppice shoot, we will frequently find that root-suckers appear at long distances from the parent tree, and become practically independent so soon as they have established their own system of tap roots."

I have not found this to be the case in Charda. Root-suckers appear to be almost entirely absent. Having no experience of sâl forests in other divisions, I am not prepared to assert that sâl never produces root-suckers but it certainly appears to be the case in Charda. The roots of over 50 young trees were examined. Digging for a foot or so was sufficient to show, either that the shoots had sprung directly from cut stumps, or (in a few cases) that they were really of seedling origin. The shoots were chosen in last year's fellings, from those found growing at a distance from any standards, and apparently springing directly from the ground as straight single stems. No stumps were visible, but this

was due to the activity of white ants, and to the fact that trees are felled flush with the ground. Moreover, shoots from small stools have little or no curvature at the base, and when one takes the lead so quickly as to kill off its rivals at any early date, there is nothing on the surface to distinguish the young tree from a seedling or a root-sucker.

One solitary instance of what might be termed a root-sucker was found. Unfortunately I did not keep the specimen, but the following is a rough sketch.



At about 8 ft. from the edge of a stump, 2 ft. 6 in. in girth, a weak shoot of the present year's growth was seen to spring from the ground, this was dug up and found to come from the side of a small club-shaped growth, arising at its lower end from a branch of the adjoining stool. The coupe in which I found this example was felled over last year. As the club-shaped growth below ground was certainly several years old, it must have originated several years before the tree was felled. It would be hardly safe to base any argument on the existence of root-suckers in general from this one specimen, I noticed it, and so mention the fact.

Study of the question of sâl reproduction leads one to ask what is the difference between a seedling and a coppice shoot? In pages 3 to 8 of the Notes, Mr. Eardley-Wilmot describes in detail the struggle which almost every sâl seedling has to go through. In all sâl forests not more than one sapling in a thousand is a "maiden" tree, that is, a tree, of which the main stem has arisen from the continuous prolongation and growth of the primary shoot. In forests where natural reproduction from seed is in progress, as the author of the "Notes" points out, the young plant practically effaces itself, so far as upward growth is concerned, until the underground struggle has been decided in its favour, and even then, the question of light has to be considered before its future is assured. This is often a matter of several years. During all this time the first shoot does not persist—far from it. The primary shoot lives for a time, and through its leaves makes its small contribution to the food-store of the young

plant, and then dies or, may be, is broken, eaten or trampled under foot. Next season, an axillary bud develops into a shoot, lives for a time, and then probably shares the same fate. And so on, season after season, for possibly half-a-dozen years.

This can be particularly well seen where heavy fellings or thinnings have taken place. Here the axe decides the struggle for light at once in favour of the young plants and as a consequence they shoot ahead very rapidly. Removal of the dead leaves and soil from the base of a yearling shoot, 2 or even 3 feet high, has often shown that the shoot in question has sprung from a bunch of dead stalks on the head of a knotty root several inches in girth.

Such is the early history of an average seedling tree. What now takes place in a coppice forest such as Charda? This forest contains trees of all sizes from nothing up to 4 ft. in girth. All but certain selected standards are felled flush with the ground in the annual coupes. In the case of small poles and younger trees there would appear to be little, if any, essential internal difference between the subsequent development of the coppice shoots from them, and of the seedlings above described. In the case of the latter, pre-existing shoots are removed by degrees by natural causes; in the case of the former they are removed artificially, all at once, with an axe. In both cases the root system is not fully developed at this turning point in the life of the plant. The coppice tree will shoot ahead of the "seedling" owing to its having the advantage of a start in root-growth, but after 20 years or so the difference in height-growth will begin to diminish. That the "seedling" should ever overtop its rival, or produce more fertile seed, on *a priori* grounds, I fail to see. Turning now to shoots from large stools one cannot but admit that there is a different set of conditions. The root-system of a stool 3 ft. in girth is probably some 40 to 50 years old and already fully developed. In the small stump a certain amount of decay from the cut surface will take place, but it is a question if, under ordinary circumstances, this will proceed right into the heart of the main root. On the other hand it is the exception, rather than the rule, to find that the root-system from a large stool does not quickly become thoroughly decayed. This represents a corresponding reduction in vitality, and so it may well be that the coppice trees from such a source are incapable of producing fertile seed to any great extent. On this head further investigation is required, as Mr. Eardley-Wilmot pointed out to me at the beginning of the present year.

In the light of the above remarks, I would answer the question with which I began the last paragraph, by stating that a hard-and-fast line cannot be drawn between seedling and coppice growth of sâl, as we know it in our Indian forests, and that, for all practical purposes, part of the reproduction in coppice fellings such as Charda (say from stools under 1 ft. 6 ins. in girth), should

be looked upon as similar in all respects to the bulk of the reproduction in forests worked under a system of selection fellings, including such preliminary operations as improvement fellings, as the greater part of the timber forests in Oudh are. If this idea is correct, and bearing in mind that in such a forest as Charda a certain number of seedlings (in the ordinary sense of the term), are appearing year after year, there should be no fear of not having, in subsequent rotations, a sufficient number of what I may call "seedling-coppice trees" to produce fertile seed for the replacement of older stools by younger ones. By seedling-coppice trees I mean coppice from small stools, say under 1 ft. 6ins. in girth.

BAHRAICH ;

F. A. LEETE.

28th July, 1899.

The botanical sources of Padauk.

We reprint below an interesting letter from Major D. Prain, I. M. S., Director of the Botanical Survey of India, to the Inspector-General of Forests in regard to the botanical sources of Padauk. As far as our own observation goes, the Padauk of the dry forests of Upper Burma agrees with that described by Kurz as *D. macrocarpus*.

"I shall be glad to render you all the assistance that I can in connection with your enquiry into the actual botanical source or sources of Padauk.

"I am aware that it is generally believed that Padauk is derived from the species known as *Pterocarpus indicus*, Willd., and that this species is believed to include not only the tree which yields the Padauk of Burma, but that which yields the Andamans Red-wood. I have already had occasion to publish my reasons for believing that the tree which yields the Andamans Red-wood is entitled to be considered, as Dr. Roxburgh originally considered it, a distinct species, *Pterocarpus dalbergioides*; but I have further been led to suspect that the Padauk of Burma is not altogether or even chiefly obtained from *Pterocarpus indicus*. My reasons for this belief are: (1) that no wood quite corresponding to the best Padauk is, so far as I can learn, exported from the Malay Peninsula or Archipelago, where *Pterocarpus indicus* is a common tree, and (2) that *Pterocarpus indicus* is not a common tree in Burma. It is indeed fairly common, to judge from our material here, as a wild tree in Tenasserim, but I do not believe that it is to be found in Burma north of Tenasserim, except as a planted tree

near Rangoon and other large centres of population. We have indeed some specimens named "Padauk bin" from Burma that are undoubtedly *Pterocarpus indicus*; but by far the greater number of our specimens of "Padauk" belong to the very distinct species *Pterocarpus macrocarpus*. If the specimens that you are now asking for are carefully collected by your officers, they will help to clear up what is an interesting scientific, as well as an interesting economic question."

In this connection I ought to point out to you that *Pterocarpus indicus* is said, in botanical works, to occur in India as well as in Burma. So far as my knowledge, derived from specimens, goes, I am inclined to doubt this. My only specimens from India of *Pterocarpus indicus*, the tree of Malaya and Tenasserim, or of *Pterocarpus dalbergioides*, the Andamans Red-wood tree, are from places in which these trees must almost certainly have been planted. The Indian tree that appears to have been mistaken for Padauk is the one that was known formerly as *Pterocarpus Wallichii*, and I believe it to be much more nearly allied to *Pterocarpus marsupium* than it is to *Pterocarpus indicus*. If it would not give you too great trouble to do so, I should esteem it a favour if you asked all Forest Officers in India, as well as in Burma, to send specimens of the species of *Pterocarpus* growing in their forests. It would thus be possible for us to make our review, both from the economic and the scientific points of view, of the genus complete and add greatly to its interest and its value."

Injurious Insects of Indian Forests.

In forwarding for circulation among all Forest Officers who may be interested in the subject and who may be willing to co-operate in the collection of specimens and data, copies of a pamphlet on "Injurious Insects of Indian Forests" by Mr. E. P. Stebbing, Assistant Conservator of Forests, Bengal, the Inspector-General of Forests makes the following remark.

Mr. Stebbing's object in writing this pamphlet is to obtain the assistance of his brother officers in collecting further information concerning our forest insect-pests, about whose operations and life-histories, so little is at present known.

The pamphlet purports to contain most of what is at present known of Indian injurious forest insects, the information being compiled chiefly from reports sent in by Forest Officers at various times. It will be noticed that this information is often of the most fragmentary description, so much so in fact, that very often it has been impossible to name the insect, whose attacks have been reported, from the scanty specimens and details sent

in. All such reports, however, have been scrupulously entered in the work, as Mr. Stebbing hopes that, attention being thus drawn to the matter, officers will endeavour to collect good sets of specimens and to make themselves acquainted with the life-histories of the pests. Such specimens, with the notes on the life-history of the insect, should be forwarded to Mr. Stebbing, who has undertaken to identify and describe, or get identified and described, insects forwarded to him.

Mr. Stebbing only requires insects that have been ascertained to do actual damage in our Indian forests.

The author of the pamphlet states, and the fact will be apparent from a perusal of the work itself, that it is generally a waste of time to forward larvæ or pupæ alone—their identification can never be carried very far, and it leads to an accumulation of practically useless information. The pamphlet gives many allusions to undetermined larvæ of families which have been forwarded with reports, that they have appeared attacking such and such trees. Such reports are at best of very little use. Mr. Stebbing points out that it is well known that numberless *Curculionid* larvæ, *Longicorn* larvæ, etc., etc., attack wood, and the mere fact of sending specimens of such larvæ does not tend in any way to increase our knowledge of the life-histories of species of these families, as they cannot be identified from such fragmentary data.

Mr. Stebbing has furnished the following notes on the collection of specimens of insects and the record of their life-history:—

I. *Collection of specimens.*—

When bad attacks of an insect are noticed in a forest, some specimens of the pests should be put into a bottle of spirits of wine or formaline. The particular tree, or area of trees, should be then carefully watched and, as soon as the larvæ commence to change into the pupæ state, specimens of such pupæ should be obtained, and may also be put into the bottle. A further watch will be rewarded by the appearance of the imago, and of these a number of species should be obtained, so as to ensure, if possible, both sexes being represented amongst the specimens collected. The imagos should not be put into the bottle but may be sent either pinned in a box or placed in saw-dust, with a piece of camphor; or, better still, with a little benzine sprinkled over them. Should the destruction be accomplished by the perfect insect (imago), specimens of the egg, larvæ, and pupæ, with dates of emergence, should be also furnished.

II. *The Life-histories of species collected.*—On the appearance of an insect attack, the following notes should be made:—

- (i) *Date of appearance.* Under this head it is *extremely important* that the dates of appearance and length of time passed in the different stages should be given for—

(a) Egg stage	...	From [here give date of laying eggs]	
		to [here give date of emergence of larvæ].	
(b) Larvæ stage	...	ditto	ditto of changed into pupæ,
(c) Pupæ stage	...	ditto	ditto do. into imago.
(d) Imago stage	...	ditto	ditto

It may be mentioned that many wood-boring larvæ often spend several years in the larvæ state boring up and down the tree. Endeavours should be made to discover the exact length of time passed in this period in these cases. Similarly, a long time may be spent in the pupæ stage. In some cases imagos lie dormant during the winter cold and only proceed to lay their eggs when the warmth of spring re-awakens them into activity again. More important still is the fact that many destructive species have *several broods during the year*. In such cases it is exceedingly important to discover and note the number of broods passed through by any species during the year, with dates of appearance and damage done, etc., etc. Without such information it is useless endeavouring to counteract such attacks.

(ii) Locality where found, with elevation above sea-level, character of forest-growth, and any other information of interest.

(iii) Tree attacked and nature of attack, whether defoliating, boring, etc.

Too much stress cannot be laid on the importance of sending, in all cases, dates of appearance of the various stages, with the locality and elevation above sea-level.

Besides the collection of specimens and information about insects that are obviously causing wide-spread damage in a forest, Mr. Stebbing points out that numberless members of the great Coleopterus families, Bostrychidan Curculionidæ, Logicornidæ are continually at work in our forests and yet the present available information as to their habits is very scanty. It is proposed that officers should have cut, here and there in their forests during the cold weather, a *perfectly sound and vigorous tree*. This should be left lying unbarked in the forest and periodical visits should be paid to it. Wood-boring insects will very soon make their appearance and their habits can be ascertained and in this way it is considered that a large amount of information on the life-histories of forest insect-pests may be obtained. In reporting attacks of boring insects the position of the tree, whether standing erect or lying felled in the forest, should be always mentioned.

For further hints on collecting and forwarding insects, attention is drawn to the memorandum on killing, preserving and transporting insects, by Mr. M. H. Clifford, which accompanied the Government of India's Circular No. 2-F., dated the 16th February 1888.

A sixty mile walk.

In the "Indian Forester" for June, "A. C." alludes to a walk I once did in the Chanda District, and it has struck me that it might not be uninteresting to give an account of the circumstances under which it was undertaken.

I had joined the Department some 15 months previously and was then in charge of that part of the Chanda Division known as the Pranhita—Godavery Sub-division which comprised some 1,640 square miles of Government Forest, including the well known valuable Allapilli teak forest. This latter forest had then been successfully protected from fire for some 18 years; so I was doubly anxious lest any fire should take place while it was in my charge.

In the middle of March 1891 I had reports that a large man-eating tiger had taken up his residence in the Mirkullu block of the Allapilli forest, and on the 24th of that month I heard that during the last few days one of my fire-guards had been taken off and eaten and also that two other persons had been killed near the fire-line. The Ranger added that all the fire-guards refused to work and that he could not be responsible if a fire occurred. These were the circumstances that decided that I must at all cost reach the spot as soon as possible. An officer M.—, a year junior to me happened to be with me in camp at Sironcha at the time, and it was perhaps partly due to his maintaining it was impossible, that I decided to walk to Allapilli the next day, my pony being laid up with a cracked hoof. I had one piece of work to do before I left the Sironcha forests

and that was to inspect a short length of disputed boundary between Government Forest and Ahiri zemindari. To go *vid* this place made the distance exactly 62 miles.

M—saw me off at 1:30 a. m. on the 25th. I decided to start early so as to get the benefit of the cool air, and as there was a bright moon it made the going at the start very pleasant. A *Gond* named Pinta who was with me in camp volunteered to walk with me, and we arranged to carry the rifle in turns. We took another coolie with us to carry food and water but he had to be changed every 10 miles or so, as it was difficult to get men to go further than from one village to another. The day, 25th March 1891, was the "*holi*" festival and rendered it more difficult to induce coolies to come with us. Short halts were thus enforced on us wherever we had to change coolies and it may have been due in a great measure to these compulsory halts that I got through the walk all right as they prevented my overdoing it in the first part of the walk as I should have done very likely otherwise. I cannot now find details of the intermediate times but I reached Allapilli at 9 p. m. that evening, very fairly tired of course, but nothing compared to poor Pinta, who having bare feet, had knocked them terribly on the rocks when he got tired. The whole road is only a cart track and over a rocky soil for a good part of the way. I had no dinner awaiting me but the Forest Ranger, who was a Mahomedan, had an excellent meal cooked for me and it was not long before I was asleep. The next day I reassured all the fire-guards and gave them buffalo calves to tie out in all the likely places. On the 30th, at about 12 o'clock I received *khhabbar* that the tiger had killed about 10 miles off near Mirkullu. By the time I made my arrangements and walked over there, it was getting late.

The buffalo which had been taken had been tied out on the fire-line some miles north of the place where the fire-guard had been killed. On the reserve side there was dense grass, 4 to 5 feet high, with scattered trees 30 or 40 feet high. Into this grass the *gara* had been taken. We followed it for over a quarter of a mile and then found that only the head and a small piece of the neck remained.

I had not much experience of tigers then, having only killed one before that, and in my ignorance I thought the tiger, especially as it was the very man-eater, would never return to such a poor meal. However, I decided I would sit up till dark and then tie up another buffalo. Thinking thus, I gaily mounted my *machan*, clad in thin *khaki*, with no food or water. Up to dusk I saw or heard nothing. About half an hour after dusk I heard a heavy animal stamping through the grass. I thought it must be a bison or buffalo, both of which are found there, but as it came nearer I could see nothing. Then all of a sudden I saw a huge tiger standing over the remains of the kill. He was standing half right with regard to me, that is, facing my left, about 25 yards off.

I immediately blazed a snap shot at him, as I could not see my sights. He rolled over into the grass, roared and pawed the ground but he had got behind some shrubs and grass and I could not see him. I fired a second shot where I thought he was and then he slowly dragged himself off into the ocean of grass, grunting terribly as he went.

Now I was in a fix, as I did not think it good enough to get down into that grass and walk a full quarter of a mile to the fire-line in the dark, as I was sure the tiger was badly wounded near by, so I decided to make a night of it. My men came a little way from the fire-line but I yelled to them to return, and there was I in a thin *khaki* suit on a *machan* some 2 by 3 feet. with nothing to eat and drink. Had I had any hope that the tiger would come I should have had a *charpoy* tied up and taken some bedding, food and water. As it was, a cold wind sprang up, and by midnight I had high fever.

Next morning I felt very bad but I was so certain the beast was dead I followed up the track, posting men in trees to keep a lookout ahead. At first the track was very plain. We found three places where he had lain down and left great quantities of blood. Then we found a place where he had apparently dragged himself along with his forefeet, all ten nail-marks being repeatedly found on the ground. However, the blood got less and less and eventually we lost the track and as the sun got hotter I felt worse, and at last gave it up. However, as after that we heard no more of the man-eater I was firmly convinced that he had crawled off to die. I had had then no experience of how well wild animals can recover from almost mortal wounds.

The next year, 1892, I happened to get re-posted to the same subdivision and heard that a tiger had taken to killing men during the past few months, but his sphere of action seemed to be some 20 miles or so south-east of Allapilli. On 24th February on returning to Allapilli from tour, two fire-guards at a *naka* a mile east of Allapilli came and told me a huge tiger had been hanging about their *naka* for two or three days. At night they slept in a high *machan* and they declared he kept wandering beneath. I gave them a buffalo to tie up at the *naka* and on the 25th morning they brought news that it had been killed. The tiger had dragged it into a thick undergrowth to the north of the *naka*, and should he remain there as I thought he would, since he was so daring, the beat would indeed be a simple one. To the south lay a cart-road, to the east a broad fire-line and to the west a broad sandy *nala*, these two latter converging a few hundred yards to the north so that the distance between them could be easily covered by one gun. By quietly placing stops on the outer edges of the fire-line and *nala* and putting the beaters on the cart-road, I had all in readiness.

I carefully stole up the fire-line and as I was afraid of making a noise by tying up a *machan*, I put on my climbing irons (which by the way I always have with me in a big forest) and climbed up a thick tree (a species of *Acacia* if I remember rightly) and sat on the lowest branch, a horizontal one, some 20 feet from the ground. The beat commenced and in a short while a huge tiger appeared leisurely walking a few steps, then stopping to look round.

I got a beautiful shot at his chest, as he topped a mound, and he rolled over ; while the recoil nearly sent me backwards over the branch, a horizontal one being most awkward to shoot off. However, I recovered my balance and the tiger his, as he took four more bullets to kill him.

I was delighted, of course, and more especially as I found he measured 10 ft. $\frac{1}{4}$ in. between pegs at his nose and tail (body 6 ft. $7\frac{1}{4}$ in. tail 3 ft. 5 in.). On skinning him we found one of my solid .500 Express bullets under the skin on his right hind-quarters and a scar behind his left shoulder. This then was the same man-eater I had fired at on the 30th March 1891. There was no doubt about it, as the direction of the bullet corresponded exactly, and no one else had been shooting with like bullets in that part. I had by mistake put in a cartridge with a *solid hardened* bullet instead of an *Express* one ; and had I placed an *Express* bullet in that position I should have bagged him at our first meeting, since the solid bullet must have passed within an inch or two of his heart, while an *Express* bullet would have broken up, and certainly have damaged the heart.

F. Z. S.

An out-caste Elephant.

The following is an account of the way a young elephant lost caste with its people, and was rejected by the jungle-folk, as witnessed by me, a Forest Officer, on tour.

It happened in this way—some nine years ago I was in charge of the Ganges Division, and after spending a few days at Chila, a bungalow on the left bank of the Ganges, and nearly opposite Hardwar, I moved my camp northwards to the Kanaun bungalow, which, unlike Chila, is built on the top of a highish cliff immediately overlooking the Ganges. In the rains, no doubt, the cliff is river-washed but at the time of which I write, there was a narrow strip of beach between the foot of the cliff and the water, and a zigzagged path led down to it from the plateau on which the bungalow was situated. On arriving in camp, as is my usual custom, I took a stroll round the '*parao*'

and it was naturally not many minutes before I found myself on the extreme edge of the cliff, from whence I knew that a magnificent view up the river could be obtained. On reaching this point of vantage my attention was almost instantly attracted to a black object in the water some way further up stream, which now and again appeared only to completely disappear again and again, but which was rapidly approaching the spot opposite to where I stood. It was not many seconds before I recognized that the strange-looking black object, was nothing more or less than the head and trunk of a young elephant, and if I could have doubted the evidence of my eyes, my ears would have told me the same thing, as every time the little beast got its head above water it gave vent to a curious scream, which was only attributable to a frightened young elephant. Calling to my orderly to follow, I ran down to the river and waded out about 30 ft. into the water by which time the water was well above my waist and it was becoming a matter of great difficulty to stand against the current, and waited for the elephant to be washed down to the same spot. By this time my orderly was also in the water and shortly afterwards the baby elephant was carried down upon us, and between us we were not very long in capturing and bringing him ashore in a half-drowned condition. He was quite a little fellow, standing about 3 ft. at the shoulder and was not probably more than a few weeks old. After landing he stood still for some minutes to recover himself and to empty himself of the water, of which he had evidently freely partaken, and which now poured from his trunk, then suddenly resenting the curiosity I evinced in his welfare, he unexpectedly charged me and,—what might be expected, was my undignified fate.

I then, with the help of the orderly and others, tried to persuade the little elephant to go to the top of the cliff, but nothing would induce him to budge a step, and the more we pushed and pulled, the more obstinately immovable he became, so I called in other help in the shape of two female Government elephants and a rope—the latter tied round the baby elephant and attached to the former was most successful and though at first the captive was only moved by brute force, he very soon trotted along of his own free will by the side of his relatives. Once at the camp he seemed very subdued; in fact it was some hours before he got over his experiences of a ducking in the river. I gave him some milk by pouring it down his throat out of a wine bottle and got him all kinds of dainties in the way of green stuff, but of the latter he would have none.

The same day, late in the afternoon, I heard far away in the distance, the frequent roaring of an elephant and I judged that there was one search party. and that the mother, out in quest of the little elephant, now comfortably installed in my camp. Thinking that perhaps I might have difficulty in rearing so young an

animal, I decided to return him to, as I supposed, his sorrowing parent. Accordingly with this intention I again fastened him with a rope to one of the Government elephants and led him forth into the jungle—time about 6 o'clock—and went in the direction of the still bellowing mother. When I thought we were within a quarter of a mile or so of her, I tied the youngster to a tree, sent my elephant some distance off, and climbed into the tree myself to watch the *tamasha*. Very soon the elephant began to answer the mother's calls and I hadn't long to wait, before she, accompanied by a big tusker, made her appearance. The little elephant in his excitement, at once forgot he was bound and charged forward, but with sufficient force to break the rope, and the next moment I saw that he was free and hurrying towards the big couple, who immediately turned round on their own footsteps and followed by the *bacha*, were quickly lost to sight in the thick jungle. This was the last I expected to see of my little elephant and after having given the reunited trio time to get away, I descended from my look-out and went back to camp. I thought no more of the elephants, till to my very great surprise, about 10 o'clock that same evening, I was informed by one of my servants that the little elephant had returned. Disbelieving the man's very improbable statement, I went out to see for myself and sure enough I found it to be a fact, and a fact which I could only account for, by supposing that the wild elephants would have nothing to do with their young one after its having been handled by man, but even if my supposition is correct, and the parents did cast him off, it is curious, that he should have thought of returning to his human friends, and in a less degree, than that he should have found his way back to my camp. Having elected me as his proper guardian, I could do nothing but keep the *bacha* and very soon he became a very affectionate pet and would follow me about and greet me by twining his trunk round my neck. For other human beings he did not manifest the same fondness and the unwary stranger usually took the same humble position as I myself had been forced to take on my first introduction, but then, his charge was irresistible. One of my Government elephants soon became very fond of the baby and I believe after a bit fully looked upon him as her own young one, and the feeling of affection being reciprocated by the youngster, the two were soon practically inseparable.

Shortly afterwards I had to make some long marches and thinking it best to have the little elephant in one place, I left him at Kanaun along with his foster-mother. To let him out of my sight was a great mistake, as I discovered ten days later, when I got a report from the *mahaut* in whose charge I had left the elephant, to say that the *bacha* was dead. The *mahaut* attributed its death to an unpropitious fate. *Kismet* has to answer for many things, and among other thing the sore back of a certain *mahaut*,

HOPLINX,

The Courtship of White Ants.

I was recently a witness of a scene in the domestic economy of white ants, which, if it has not been previously recorded, may prove of interest.

I was out for an evening stroll in April, after a smart shower of rain, when I noticed the air to be fairly thick with the winged sexual form of the common white ant (*Termes taprobanes*) which were pouring out of several holes in the ground.

They flew about at first in an aimless way affording an evening meal to a number of birds, among which several kestrels were conspicuous.

After a time certain individuals (females) settled on the ground or on rocks, in conspicuous places, and began to vibrate their wings rapidly. This was obviously to attract the attention of the other sex, for in a short time in each case, another ant, this time a male, settled close to the first and ran up to her.

Upon the arrival of the sterner sex, the lady-ant ceased fanning and began to run away, being followed closely by the former.

The chase usually lasted some time, the coy female being apparently unwilling to be won too easily, or possibly wishing to test the perseverance of her admirer. After a time, however, she allowed herself to be caught, and then the strangest thing of all happened. The male deliberately bit off the wings of his mate, one by one, and having done so he threw off his own, by a curious jerky movement which was difficult to follow. I would not be certain that his legs were not partly used in divesting himself of his wings, but although I watched the proceeding carefully in several cases, I could not be certain how it was effected. The wingless insects then walked off, the female still leading, and entered the first convenient hole in the ground they came across, where I presume they started a fresh colony.

B. B. OSMASTON.

White Ants and living Bamboos.

It is generally supposed that white ants eat only dead things, but recently a case of their attacking young mango trees has been brought forward, the plants being attacked, if I

remember rightly, very soon after being put out. There is reason to believe that the planter was also put out as soon as ever he discovered it.

Recently, there were a lot of 2 to 3 year old plants in baskets put out in my garden, viz., 20 camphor and 70 bamboos of various species. The day after planting, or may be two or three days after (for the work lasted 3 days) all the plants looked flourishing except that the leaves on a few shoots had rolled up as though scorched by the sun. Now, there had been no sun. A slight pull revealed the fact that the shoots had but half an inch of stalk in the ground and appeared to have been eaten off. Further search brought out some white ants, still clinging to the eaten ends, so there could be no further doubt as to the culprit. Up to the date of my departure only about half-a-dozen plants had suffered, but this I put down to my having at once manured the white ants with a dilute solution of phenyle. They may perhaps return as soon as the effect of the dose has passed off. On the other hand they may only attack plants that are actually in difficulty, and the roots may have established good connection with the soil before they return.

This touches the question whether, in basket-planting, the basket need be removed. The general practice is to slit the basket before putting into the pit so that it can be pulled out when the young plant is seated. But baskets are often so rotten that the greater part of the basket remains buried. Is any harm done? Some say the bits will attract white ants. Others say they make no difference. There can be no doubt that they will attract any white ants that find them. But that need not necessarily make any difference to the plant. Possibly the debris may lead the white ants to attack the plant, but it can, I think, not be laid down as a rule that they will do so. On the other hand it is possible that the remains of the baskets may be of use in keeping the white ants employed till the young plants need no longer fear attack. The question is a difficult one to work out experimentally, so much depending on the numbers (and perhaps species) of the termites and on the available quantity of other food.

F. GLEADOW,

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Our Illustration.

The photograph we reproduce with this issue represents the Rhinoceros described by F. Z. S. on pages 265-8 of the June number of the *Indian Forester*.

Concessions.

All those who appreciate the general subject of the economic welfare of India, and are alive to the very real place the 'Forest' plays in that economy, will have read with interest the able and temperate paper in the April number, on the effect of 'Concessions' of (free, or partly free) grazing, timber, &c., in the Oudh forests—'concessions' being made in cases where, it is admitted, no kind of *right of user* exists. It is rather late perhaps, to pursue the subject, but it takes time for papers to reach England and be answered; and as a matter of fact, the question, in this instance, does not depend for its importance on the precise moment. Such cases constitute an abiding difficulty in Forest management; and if the natural tendency of Forest Officers is to turn away from such—to them hopeless—difficulties, and rather devote their attention to interesting questions of silviculture, it is not the less necessary, from time to time, to take out into the light, the very serious menace to the economic welfare of the agricultural population which such cases indicate. Forest Officers are ready to exclaim. 'What can we do?'; and naturally so: but that makes it all the more important to undertake the unpleasing rôle of a 'prophet of ill,' and by seriously calling attention to dangers ahead, to exculpate ourselves from any future charge of indifference, or of complicity in the matter. If the responsible authorities refuse to take warning, upon them must rest the responsibility for the consequences.

The whole circumstances of the *right to land*—whether waste or cultivated—in British India are extremely peculiar. When the British Government obtained (by grant, cession, or conquest)

the administration of the provinces, it succeeded on well known principles of law, to all the *de facto*, long-settled claims and rights of the preceding Government. And as regards the ownership of land, it is no doubt obtained on almost absolute right; but the right was such that it could not be exercised, by a civilized Government, without large modifications.

We may put aside here the question of the general State right as regards cultivated land, because that was definitely met and disposed of sometimes by means of 'landlord' arrangements, as in Bengal, Oudh and other places; sometimes by the recognition of the right of village communities, which were given the proprietorship of defined areas, both waste and cultivated, within the village boundary land down by survey; sometimes on the *raiyyatwari* principle, as in the large provinces of Madras, Bombay, Assam or Burma.

But the right of the State to dispose of or retain for public use, the waste and forest area, is among the most ancient and undisputed features in oriental sovereignty. It is probably as old as the Hindu monarchy itself. No sovereign ever felt any doubt about his right to retain large areas as hunting grounds, or to punish with ruthless severity, any injury to woods or to wild animals—even when the latter were committing depredations on the crops or were actually dangerous to life in the adjacent villages. When such a reservation was not contemplated, the right to issue unfettered grants to cultivate and 'reclaim' the waste was a matter of daily custom and exercise. And there were often Feudal Chiefs and subordinate magnates who had a virtually similar right in their domains. And when these afterwards (as often happened) became 'landlords' under British rule, it was a question how far large areas of waste and forest—entirely unoccupied and not 'possessed' in any tangible form by them—could be held to form part of the 'estate' recognized as their property. Very often the matter was left undefined, at the outset; the estate was neither demarcated or surveyed, and thus there was no equitable decision as to what lands were, and what were not, included. After some years, it was found impossible to do anything and so large areas were practically lost to the Government and to public use.

But, apart from the State right to forest and waste as a general and unquestionable fact, the *practice* of all times introduced limits. The right was only exercised in such a way as not to interfere with grazing grounds close to villages, or to prevent the acquisition of the necessary fuel and wood. When the British settlements were put in operation, it was often possible to provide for the customary and indefinite user, either by assigning a tract of 'waste' to the village as its joint-property, or by leasing certain lands set apart for grazing, &c., which were never included either as State Forest ('reserved'), or as that vague kind of thing called 'district forest' or by some equivalent name.

But, after all such arrangements were made, there were still cases in which the tracts of woodland, fairly, and on general grounds, claimed as State or public forests, were resorted to by adjacent villagers or by nomad tribes; and the Government had for many years taken not the least notice of such customary user, any more than it had of the forest itself. It is true that here and there, exceptionally valuable forests of teak, sâl or sandalwood received some kind of attention. Of late years it has been the fashion to magnify these spasmodic acts into important efforts at conservation; but at best they were made in total ignorance of the most elementary considerations of forest knowledge; they were mere efforts to defeat rascally contractors and get a cheaper and easier supply of timber for public works, and usually ended in the local extermination of the valuable species. Occasionally, too, an enterprising officer would start a plantation, of which Nilambur is a noteworthy instance; but such attempts, however praiseworthy, have no real effect on the general economic condition, from a forest point of view. All the early action taken regarding the southern forests, was taken without the least conception of the all-important question of the "possible yield" or of the replacement of the extracted stock.

But this is a digression:—the real fact is that forest questions received no general attention for nearly a century after British rule began. It was not till 1828 that the Bengal law formally declared the ancient rule, that waste and unoccupied land belonged to the State. And in 1860, when Lord Canning wrote his celebrated minute urging the utilization and disposal of waste lands in general, not a word was said about reserving tracts of wooded or grass lands for public forest purposes.

When at last the Forest question was really taken up with practical knowledge and ability in Burma, under Lord Dalhousie, and some years later reached the Indian continent, the invasion of forest tracts in many parts by the host of right-holders(*usagers*) had so long been permitted and grown customary—with the increase of population and the multiplication of cattle which resulted from the *pax Britannica*,—that it was impossible to suggest any harsh or summary dealing with the case.

The strict legal position of such users of the forest, or its products, it was equally impossible to define. Legal arguments might show that the exercise was not 'prescriptive,' the conditions of a legal prescription were wanting; and so forth. But all such technicalities were necessarily and properly brushed aside; it was decided to deal with "forest-rights" as if they were 'rights' in a European forest country. They were not only recognized in principle as such; but far more liberally dealt with them than in France and Germany; that is to say, the rights were allowed, and the conditions of proof, the restrictions and limits and other counter claims, were not prescribed. The time was not ripe for legal niceties, and the Forest Act did the best it could (under

the circumstances of much ignorance and opposition). There has, therefore, always been a considerable laxity in the terms—and still more in the application—of such rules as exist. 'Rights' have been allowed, in cases where there was no title or no ground for them; the 'definition' such as the law requires, was not carried out; and so forth. But still something was done; and it was useful as far as it went: when once the essential points of a tolerably definite local claim, and a record of some kind are attained, it is always possible to effect improvements afterwards.

These considerations of the freedom, and even laxity, with which 'rights' were allowed, are not irrelevant; for when such provision was already made, it follows that the grant of 'concessions,' though obviously within the power of the Government, ought to have been very sparingly made; and only in cases of real and proved hardship. The case in Oudh seems to have been one quite outside this exception. Why should the mere accident of being within an (arbitrary) three-mile limit give a claim to consideration? Other villages, further off, would be just as much in need of the help. It amounts to this; that certain holdings are favored by a pecuniary advantage over others, in paying their rent, that is what it comes to. And as regards cattle-owning tribes not belonging to the locality, nothing can be said in their favor. It seems as if the power of 'concessions' was to prove an easy means of avoiding the Forest law, already wide enough in its terms.

But it will be said; it is no use raising such questions; the authorities *will* have it so. The real truth is, that they do not appreciate any question of forest economy; and their firm, if unconfessed belief, is that forest conservancy is more or less of a fad, or at least only applicable to limited tracts of undeniably valuable timber-growth. It is a fixed opinion that if the common woodlands of the country are let alone, without any treatment except the prevention of gross abuses (of which burning the forest is not one!) the forest will go on supplying grazing, grass and ordinary wood to any extent whatever; and it is mere folly to prevent the people from doing whatever they please—short of breaking up the soil for cultivation.

The only thing that can be done is to give a serious warning, from time to time, that such notions are absolutely fallacious. But something can be done to check the evil.

In the first place, if 'concessions' are given, it should surely be *only* to residents, not to outsiders; it should be solely for personal use and not for sale: the only exception being where the petty sale of bundles of grass, gathered leaves and bamboos is the privilege directly contemplated.

In the next place, the *financial* aspect of forest conservancy is surely one that will, at any rate, be intelligible to the authorities on all grades. Now, in the case of rights, the value of the produce

taken is of no account, because, *ex hypothesi*, it does not belong to the State : what the public has to consider is the residue which belongs to it after such deductions are made. If I have an estate of £300 nominal, but subject to a permanent jointure of £100, I can only consider £200 as the effective property which I have to deal with—as far as value is concerned. But with ‘concessions’ it is quite otherwise. Here the State is giving away, voluntarily, what it might otherwise apply to the reduction of taxation, and the public should know, approximately, what is thus being taken from the public purse. This would be only one point : but it is something.

Then, there is a consideration, which is perhaps the most important of all. What will become of these people you are favoring when the forest, worn out with the excessive grazing, burning and unreplaced cutting, becomes a barren waste ? People *must* be made to face this, for at present their only answer is a vague belief in the practical inexhaustibility of ordinary woodlands. they cannot realize that in every class of forest it is our imperative duty to take the annual increment, not the capital; and that there is a limit to the annual increment, much narrower, than is supposed. The worst feature of ‘concessions’ is that they are almost invariably made without giving any plan of allowing the different parts of the forest any rest or recovery ; and they are made without the least thought or calculation whether the forest can properly yield this amount of material or grazing or not.

Efforts should be persistently directed to establishing an approximate estimate of amount of wood that can be taken in those concession areas, even if it is more generally and widely stated, than is the case in regular forests. And it should be resolved to consider the ‘possibility’ of grazing and find some rough and ready rule for fixing numbers. People can then be told ; this is the total amount of wood of kind (*a*, *b* and *c*) you can have ; arrange among yourselves how it is to be divided : this is the area of grazing that is open ; and this is the number of cows, buffaloes, sheep, &c., it will support : determine among yourselves how many cattle each person is to graze accordingly.

B. H. BADEN-POWELL,

Oxford, August 1899.

The Regulation of Pasturage.

The *Revue des Eaux et Forêts* for the 1st May last, contains a long article on the Regulation of grazing by M. M. Broillard and Cardot, which seems worthy of reproduction at some length in the

Forester, as many of the difficulties described are equally to be met with on the hill regions of India. In the same Review for the 1st April, there was an account of the work of the Agricultural and Sylvicultural Improvement Commission which had adopted M. George's conclusions regarding the necessity for special legislation in respect of grazing, based on the two following principles.

Compulsory limitation of the number of animals admitted into communal grazing grounds.

Equal division of the possibility among all the participating inhabitants.

M. Phal, Conservator at Chambère, the originator of this idea, justified his proposal before the Commission as follows:—
“ It is obvious to any one who has studied the Alps that the tendency of communal pastures to degradation owing to abuses is becoming greater and greater. In most of the communes of Savoy and l'Isère the management of the pastures has become a regular exploitation for the almost exclusive benefit of a few inhabitants who are fortunate enough to possess flocks, and who, for a generally very small tax, absorb the whole of the produce of the communal lands to the detriment of the rest of the inhabitants. These inhabitants have for the most part a considerable influence in the commune, and it is generally they who strenuously oppose every restorative measure from fear of seeing the area which they exploit diminished. It is quite a different matter when their own personal properties are concerned; these are managed with the greatest care, and form, as it were, oases in the midst of the communal desert.

It may, in fact be said that the communal pastures are exploited almost exclusively by a few large proprietors of flocks without the other members of the community deriving therefrom the least advantage. This is the reason to which may be chiefly attributed the check the proposed grazing regulations have received in the communes concerned. No project has been allowed to develop, for the simple reason that the large proprietors were for the most part the influential members of the Municipal Council. The same opposition would be met with now.

The first and only measure to take would be to modify the method of making use of the communal and mountain pastures. Grazing, like wood, should be allotted, each house should receive its fair share of the produce.

Suppose for example a certain mountain is capable of supporting 1,000 sheep, and that the commune contains 100 houses, each house would have the right to graze 10 sheep. Conformably with the rules regarding wood, each member of the commune would have the option of making over the whole, or a part of his right to a third person.

In this manner the poor man as well as the well-to-do would have an equal and tangible interest in the preservation of the

communal pastures. Such a measure would be essentially democratic, and I am convinced that its application would abolish a great number of difficulties and abuses."

M. Campardon, Forest Officer at Saint Giron, gave a similar account of the state of affairs in the Pyrenees.

In 1897, M. Guenot, who is not forest official and who knows the Pyrenees well, described the situation there before the Congress at Saint Nazaire in clear and forcible language. He concluded by saying that for centuries the pastoral population had done immeasurable damage to the mountain slopes. "It is high time that other interested persons, the people of the plains should make their voice heard and demand protection and security for their properties and their persons, both of which are compromised by the destruction of the mountain slopes. It will be impossible to tolerate much longer the present state of affairs. Any private individual who managed his property in the unreasonable way in which the country manages its mountains, would be considered an irresponsible lunatic and would have the management of his affairs taken away from him."

Thus, in the Pyrenees as in the Alps, the private interests of a few, sometimes even only one, two, or three individuals, have always been able to override the interests of the public.

A letter addressed to the Sub-Prefect of Briançon by the Municipal Council of La Roche (Alps) and dated August 1853, is reproduced in full in evidence of the extent to which the pastures, &c, were made use of at that time. The letter is an appeal for the abolition of certain rules issued by the Prefect reducing the number of animals each head of a family was entitled to graze, to eleven sheep and one goat. The object of this limitation by the Prefect was obviously to satisfy the wants of all. This, however, did not suit the petitioners, as there being about 200 houses in the commune the number of sheep and goat admissible under this rule would have been reduced to about 2,200 and 200, respectively.

Had the grazing been allotted from that time, the communal lands of La Roche would now have been husbanded for half a century and the same would have been the case in a large number of the communes of the French Alps. But the best intentioned Prefects have been unable to bring this about and the leading men of each commune have continued to overcrowd the pasture lands, and the State is now endeavouring, at considerable expense, to repair the damage done.

Everyone knows how the allotment of the wood of an ordinary annual coupe of the communal forest is made to the inhabitants. The general rule is to divide the timber and fuel by house, that is, by each head of a family or actual domicile existing in the commune before the publication of the allotment roster for the year. Formerly the timber was distributed among the inhabitants according to local usage. In the East, for example, the custom

was to distribute the timber in proportion to the covered surface of the houses.

It is easy to understand that such a method of distribution originated at a time when the trade in wood practically did not exist and timber was not of much more value than fuel.

With the development of means of transport, the price of timber increased enormously, and with the progress of ideas of equality, unequal allotment became insupportable and the law of 23rd November 1893 settled the matter easily and simply by generalizing the distribution per dwelling.

No doubt, similar modifications have taken place in the condition as well as in the methods of enjoyment of the communal pastures as in the case of the forests. It is certainly probable that in the last century the inhabitants possessed very different sized flocks and grazed, some of them perhaps five, and others five hundred head. There was no doubt grass enough for all; but during the present century the deterioration of the land has gone on increasing progressively. Unequal enjoyment has increased to the benefit of the rich proprietors; to the animals maintained throughout the year they have added those kept for trade purposes, with the result that the pastures are overcrowded to the ruin of the mountain slopes and injury of the common right as well as public interests.

One might ask how it is that the mass of the inhabitants have submitted to such an iniquitous state of affairs for so long. In the case of the people of Briançon they seem to have become so accustomed to malversations and extortions of various kinds that they regard them as inevitable and put up with them, as the Turks might do, under the influence of a sort of fatalism. There is no lack of examples showing this to be the case. One of these is given at length and relates how a forest guard, in return for bribes or other favours received, allowed people to steal wood from the communal forest. For a long time, by the connivance of the guard, the offences escaped detection and finally the guard was prosecuted under Section 6 of the Forest Code, which makes him responsible for offences in his beat which are not brought to notice. The Mayor of the commune, consulted as to the conduct of the guard, replied by four pages of eulogy on the excellent qualities of this official. The prosecution, however, took place, and the guard having absconded, was convicted in default. Once the commune was relieved of the presence of this rascal, every one was only too eager to come forward with accounts of his misdoings, and the same Mayor referred to above wrote to the Forest Officer to thank him for having removed such a scourge from the commune. Both these letters are on record.

There is no reason to suppose that the inhabitants of other communes are much different, and it is hardly to be expected that such people will undertake their own defence and insist on their right in the matter of pasturage. If they wished to do so, the

matter is very simple; they have only to elect a Municipal Council capable of voting, for equal allotment per house or per inhabitant. In any case, as it is a matter of public interest, the State should intervene and it is perfectly easy for it to do so.

There is not quite the same reason for regulating the enjoyment of the pasture per dwelling as there is in the case of the right to wood. The essential object of the pasturage is to supply food and clothing by means of the animals grazed, and it is more natural, therefore, to regulate the exercise of the right by the individual than by the dwelling house. It would be only fair that each inhabitant should have the same right to pasture, and once such a system were made legal, the people would be only too glad to see it enforced.

The present state of affairs, where only one or two individuals are interested in the pastures and these only to make all the use of them they can, is a hopeless barrier to all measures of improvement.

A common interest would be much less obstructive, for with equal rights every one would realize that any expenditure on works of improvement or preservation would be to the equal benefit of all, and with an intelligent Mayor, interested in the welfare of the commune, the restoration of the pasture lands would be possible. If there are any communes where the pastures are not overcrowded, anyone who took the trouble to enquire would without doubt find that the right to pasture is exercised fairly equally by all the inhabitants.

In this respect the example afforded by the communal forests is instructive. The greater majority of them are in good order, and if there are cases where half a century ago there was disorder and ruin, it was in those communes where the inhabitants helped themselves, or at any rate exercised unequal rights to wood, pasturage, or other produce. Under the protection of the system of equal rights for all, the forests prosper and the commune accepts successive measures of improvement, working plans, increased rotations, efficient protection and so on. It is not once nor altogether that the communes consent to expenditure and economies on account of their forests, it is successively and generally by force of the example furnished by one or two, whose Municipalities are endeavouring to do their best for their forests with the aid of the Forest Department.

M. Broillard concludes his portion of the article by an appeal to M. Cardot to add his opinion in support of the question of equal allotment.

M. Cardot then continues the article in Part III. He commences by expressing a doubt as to the possibility of limiting the number of animals grazed without, at the same time making some endeavour to assure a production in accordance with the requirements of the inhabitants.

M. Cardot also doubts whether the mere limitation of the number of animals would be sufficient to bring the pastures into

a satisfactory condition. He maintains that it is not only the excessive numbers of animals grazed, but the total absence of all measures of protection that has led to the present deplorable state of affairs.

There are always natural causes of deterioration at work in the hills. In one place a landslip or avalanche covers the pasture with stones; at another point the soil is eroded, and if nothing is done to prevent it, it will in time be cut away into a ravine by the water. Whatever the cause of the deterioration of the grass land, the cattle become more and more concentrated on those parts which have escaped, thus accelerating the ruin of the whole. A time eventually comes when the area is no longer capable of supporting the flocks, and if these are the only resource of the inhabitants they must emigrate.

An example is quoted of a certain village in the Hautes Alps in reference to which the writer, noticing the denudation which was going on all around it, remarked that "should he return that way in twenty years, he would hardly expect to find the village there then." Within five years the inhabitants had negotiated the sale of all their lands to the Forest Department and at present the only house now existing there is the Forest House, and tree growth is now beginning to repair the damage done by man's carelessness and excessive grazing. Mountain grazing-lands require care and repairs very much the same as a house does, if either are neglected for a long time ruin results, whereas by judicious repairs the damage can be prevented. It is, however, the common property of all such communal lands to be cared for by no one and to become less and less capable of satisfying the wants of all.

Restriction of grazing is not always sufficient to protect a disafforested hill from deterioration, due in great measure to the development of natural causes, nor yet to save the inhabitants from the cruel necessity of emigration. A law to prevent abuses is no doubt required, but this must also be supplemented by legislative and administrative measures capable of ensuring the carrying out of such works of restoration and maintenance as may be required.

The Agricultural and Sylvicultural Improvements Commission has already rendered signal service to the country in proclaiming the principle of allotment of pasturage. It remains for it to complete its patriotic work by indicating to the proper authorities and to Parliament the measures which ought to be taken to secure the carrying out in the pasture lands such works as are necessary to ensure for the mountains and their inhabitants the benefits of Pastoral Culture.

The immensity of the task need be no deterrent. The work of reboisement and the correction of torrents appeared sufficiently difficult when the law of 1860 was first applied, yet neither difficulties nor expense have proved an obstacle in this

case. Is it any more difficult to re-establish grass where damaged, than it is to create a forest on denuded moving slopes? Is it more difficult to prevent the formation of ravines where this threatens, than to fix the beds of those ravines which are the outlets of the reboisement areas? Is it any less useful, in short, to re-habilitate lands still capable of production, than to consolidate ruined slopes? The reply to these questions is clear and it is time to consider what measures should be taken to ensure the desired result.

M. Cardot after mentioning the possibilities of utilizing the Forest Department to help in the work of restoration, then discusses the question of expense, and concludes by comparing France of the present day with the lavish luxury of Paris, to a castle with a brilliant drawing-room in which to receive its guests, and a tottering, tileless roof, supported by cracking, decrepit walls, and asks whether it is not time that some of the golden sap which congests Paris to such an extent as to give it brain maladies, from which every one suffers, should be diverted into the province.

Finally he calls on the Commission to prepare a complete project of legislation as the "Régime pastoral" in doing which he states it will have prepared the way for one of the most important and fertile of all agricultural improvements.

Life-history of the "Tun twig borer," *Magiria robusta*.

Early in July 1898, when the time arrived for the collection of tún seed, it was discovered that the bunches of fruits on the tún trees at Changa Manga were covered with a spider-web-like silken mass and that the fruits contained no seed, consisting of mere empty shells, each with a round hole in it, the inside having been completely devoured. Entangled amongst the web were reddish-coloured excreta, similar to that of a lepidopterous insect. No living larvæ were to be found, but a few empty chrysalis cases were found entangled in the web of the trunks of the trees.

On September 19th it was brought to my notice that the shoots of a clump of tún coppice had turned brown and were dead. These shoots were examined and it was found that they were hollow, the whole of the pith having been eaten, which had caused the shoots to wither. By splitting the shoots the culprit was found, namely a lepidopterous larva, about one inch long, bluish in colour with black spots and with short stiff hairs. A number of pupæ were also found in the larval burrows, enclosed in a dense white closely-fitting cocoon. I was informed at the

time that this damage was only found on the coppice shoots; but further examination showed that almost every young tún plant recently planted out was attacked in a similar manner. Even shoots on the large tún trees were also attacked in this way but it was the young plants which had chiefly suffered.

The attack always appeared to commence from the axil of a leaf, the young larvæ evidently having devoured the young bud and entered the shoot at the weak spot, from which a mass of gummy substance had exuded. Terminal shoots destroyed, were often over a foot in length. This is serious damage to young plants, as it leads to the trees being forked, and renders it almost impossible to obtain clean straight stems of any height.

A number of larvæ and pupæ were collected. The first moths appeared on 16th October, having been about a fortnight in the pupal state.

Remembering that tún fruit had been found destroyed in July last year, search was made early in the spring to try and find out the cause. On April 24th, 1899, the unripe fruits were examined, and it was found that they were already attacked and the culprit was discovered in a green unripe fruit, which it had entered by making a round hole from the outside. The culprit was a lepidopterous larva and was identified as being the same as that found in September in the tún shoots.

On other trees, which were still in flower, numbers of young larvæ were found on the inflorescences and were feeding on the petals of the flowers and young fruits. The young fruits were eaten bodily; but older fruits, whose outside had become harder, were burrowed into and the contents devoured, leaving nothing but an empty shell with a round hole in it. Having devoured the contents of one fruit, the larvæ leave it and attack another one in the same way. The inflorescences were covered with silken threads, in which were entangled excreta and pieces of partly-eaten petals.

By May 1st, the larvæ were more or less fully grown and were to be found in swarms, on the trunks of the trees, and appeared to be searching for suitable places for pupating. The trunks of the trees were covered with a dense mass of silken threads. A search was made for pupæ, but none were found. A number of larvæ were collected and by 29th April most had pupated. The first lot of moths appeared on May 6th, the pupal state having only lasted one week; and by May 15th all the pupæ had changed to moths. A few cases were also found in which tún shoots had been tunnelled into, and with larvæ in them, but this appeared to be very unusual, and was only confined to cases where no flowers or fruits had been produced on the plants.

Search was made for pupæ on the trunks of the trees, where I felt convinced they would be found, but no pupæ could

be discovered, which puzzled me very much. One day, however, May 27th, I stripped off some pieces of bark, and then the pupæ were discovered in masses, packed closely together. They were quite invisible from the outside, being right underneath the pieces of peeling bark. The pupæ were enclosed in white cocoons, similar to those found in tún shoots.

At the beginning of August it was found that larvæ had commenced to attack the tún shoots, and this completed the life-history. From the above, it will be seen that there are two generations of the insect during the twelve months, as follows.

1st Generation.

Larvæ.—Appear at the beginning of April as soon as the tún trees come into flower, continuing until about the middle of May and feeding on petals, young fruits and ovules of the tún tree.

Pupæ.—This stage lasts during latter half of May. The pupæ are red in colour, about $\frac{3}{4}$ in. long, and are enclosed in a dense closely-fitting silken cocoon and are found packed closely together in colonies underneath the peeling bark of main stems.

Imago.—The moths emerge from the pupæ at the end of May and are to be found throughout June and July.

Eggs.—Not found; but are no doubt laid on leaves or stems of tún plants.

2nd Generation.

Larvæ.—Appear at beginning of August and continue in larval state until end of September. They tunnel into young succulent shoots of tún plants devouring the pith, which causes the shoot to wither.

Pupæ.—This stage lasts during first half of October. The pupæ are enclosed in cocoons similar to the above, and are found in the larval burrows in the terminal shoots.

Imago.—The moths emerge from pupæ about the middle of October. It is not known how long they live or when the eggs are laid. As the tún tree loses its leaves at beginning of November, the eggs are either laid on the stems of tún trees and lie dormant throughout the winter, hatching into larvæ at beginning of April, or else the moths live through the cold weather and lay their eggs very early in the spring as soon as the young leaves of the tún tree begin to appear. The former is probably the more likely.

The larvæ of both generations are very destructive and attack and destroy, in each case, the most tender portions of the tún tree. In the 1st generation the tender petals, young fruits and ovules are destroyed, and in the 2nd generation the larvæ devour the pith of the youngest succulent shoots, causing them to wither.

Remedy.—On a large scale little can be done against this pest; but where young plantations exist, much good can be done by cutting back the attacked shoots carefully above a bud, at about the middle of September or just before the larvæ pupate. The shoots containing the larvæ should be burnt to destroy the larvæ. The bud below the cut will develop and produce a shoot which will replace the old terminal shoot, and it will have the whole of April, May, June and July in which to put on growth before it is likely to be again attacked. Tún grows rapidly and in a few years attains a good height, after which the damage is of no great consequence, as it is confined to branches, which will no longer affect the bole. During the first generation a great many larvæ might be destroyed by collecting them from trunks of trees, about the beginning of May before they pupate, or pupæ could be collected and destroyed by peeling off the pieces of bark containing them and burning them. In any case if timber trees are required, it will be necessary to prune them, otherwise the boles are forked very low down.

The following diagram shows the life-history in a convenient form.

Year.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1898				—	•	+	+	+	+	+	+	+
1899	+	+	+	+	+	+	+	+	+	+	+	+

+ = imago or moth ; + = imago and egg stage ; — = larval stage ; = Pupal stage ;
 ■ denotes period during which insect is destructive.

The egg stage and duration of the imago stage in the second generation is doubtful. The larva when young has a reddish tinge with black spots, but when mature is a distinct blue colour with the black spots. It is about one inch long when mature and rather fat. The head is black and the body is clothed with short hairs. The moth is brown with black marks on the veins, which are not very conspicuous and has a pearly lustre. It is about one inch across the wings. The insect is described on pages 122 and 123 of Mr. E. P. Stebbing's book on Injurious Insects of Indian forests and is figured on plate VIII of the same book.

12th August 1899.

B. O. COVENTRY.

Forestry at the Cape.

The Reports of the Conservators of Forests at the Cape of Good Hope for 1896 and 1897 have been to hand for some time, but have been crowded out by pressure of other matter. They are naturally published a year later than the period they refer to.

There does not appear to be any Central authority on forest matters, the four Conservators, Western (or Cape Town) Midland, Eastern, and Transkei being severally, responsible to the Minister of the day or hour. Consequently, forest policy, though not the standing disgrace it is in Australia, is yet on a footing that is far from satisfactory to the well-wishers of the colony or creditable to the politicians who keep it so. There is also a Ranger for British Bechuanaland. There is no guarantee of permanence, either for the forest area or for the management thereof, and there is no want of "enterprise" to take every advantage of the weakness of the Department. Under these circumstances great credit is due to the Conservators, Messrs. Hutchins, Heywood, Lister, and Henkel for the excellent results they have already produced.

The forest area of the colony is extremely paltry, being 29 per cent. of the total area, and even this much is not assured from political and commercial attacks. A country like the Cape ought to have at least 25 per cent of its area under forest, and it is quite possible for this amount to be obtained without trenching on areas valuable for agriculture. In support of his statements as to the climatic benefits to be expected, Mr. Hutchins cites the well-authenticated case of the Santa Clara Valley in California, well-authenticated in spite of the former absence of rain gauges. The valley is 60 miles long and 12 miles wide. It contains no less than 6 millions of fruit trees, mostly 20 ft. apart, and is thus, if not quite a forest, still something very like it. The oldest inhabitants assert that the climate has changed. Those who may choose to assert that it has not, have to explain away the awkward fact that for many years at first the trees could not be established *without irrigation*, whereas at present *irrigation is rarely resorted to*. The rain fall is now about 22 inches.

The revenue of the various Conservatorships runs to about £22,000, and the expenditure to about £50,000. The profit, for it is profit, is mostly due to planting. There is good hope for a country that is stiff enough in the back to do this in spite of politics and commercial enterprise.

There is another good point about these reports, *viz.*; the whole basis and calculation of the Working Plan is fully explained, so that any one capable of understanding such matters can know what is being done and have the chance of criticising it.

Owing to the destruction of the indigenous forests, the Cape department finds itself under the disagreeable necessity of doing things it does not like; for instance, cutting up splendid timber-trees like yellow-wood for railway sleepers. This "yellow-wood" is almost the only common name of a tree that is not to be found in any of the lists given; possibly it is the same as "upright yellow-wood" or simply "upright" (*Podocarpus*

Thunbergii). At present, the colony has to send annually about a quarter of a million sterling out of the country for sleepers, which it is quite capable of producing on its own land, and would have been producing had ordinary care and foresight been exercised from the first. To meet the future demand for sleepers, &c., great plantings and sowings are going on, mostly of cluster pine (*P. Pinaster*) round Cape Town. Five or six tons of its seeds are used annually. Some hundreds of pounds worth of seeds are sold to the public at cost price, in order to encourage planting by farmers and others.

There is also a Planting Act, under which municipalities may spend money on planting and are reimbursed one-half the cost by Government. This system seems generally to work well, but the Cape Town Municipality would appear to have been wasting its own, and the Colony's money on the "penny-wise-pound-foolish" principle to such an extent as to call for interference. Municipalities in general are not unmixed blessings, and this one seems no exception. In the present case, the Cape Town water-supply is not all it might be, and will certainly have to be largely increased in the future. Accordingly, large plantations have been made on Table mountain, and the lower portion thereof was mostly afforested, when the Town Council influenced the Minister of Agriculture so that further planting was stopped. Some crank or cranks had alleged that tree-planting was not favourable to water conservancy. It may be remembered that there were not wanting wiseacres who said the same about the Bombay water-supply at Tansa. It is evident that impounded surface water cannot be as clear and pure as spring water, and the Table mountain water seems to be brownish, but far worse is the water from George and other sources of supply that are on open land. There are, however, solid facts bearing on the case. The "Silver" river near George was so called from its former crystal quality. Since the forest was destroyed, it has become brown and repulsive-looking. The Swart, Kaimans, Touw and other rivers now run with discoloured water, rise and fall rapidly, and run nearly dry in the hot weather, all this since the forest disappeared. As one travels further to the Glebe river at Knysna and westward to the Storms river, the forest is still standing and the rivers run crystal.

Among the most remarkable points discussed in the Reports must certainly be considered the experiments on the rate of growth of cluster pine (*P. pinaster*), stone pine (*P. pinea*) and blue gum (*Eucalyptus globulus*). At Plumstead, as representing a good average of the Cape Flats, two determinations have been made. Mr. W. N. Brown made the annual acre-increment to be 380 cft. This was so large that Mr. Hutchins made fresh measurements, and arrived at 342 cft., which certainly appears little less than marvellous. The figures are worth quoting :—

Area measured :212 acres aged 14 years

Stock 311 trees = 1467 trees per acre

Total stock on area = 1737·06 (ideal cylinder-contents) \times 0·65
(form factor) = 1129·09 cft.

Stock per acre = 1129·09 cft. \div ·212 = 5325·89 cft.

Yearly increment of average tree = 1129·09 \div 311 \div 14
= ·26 cft.

Yearly acre-increment = 5325·89 \div 14 = 380·42 cft.

Do do in tons = $\frac{380·42 \times 66·53 \text{ (sp gravity)}}{2240}$

= 11·30 tons green wood.

or $\frac{380·42 \times 36·06 \text{ (sp. gravity)}}{2240}$ = 6·12 tons dry wood.

The specific gravity of wet wood was got by cutting and weighing 6 logs, each 4 ft. long. The weight was 265 lbs. The mean diameters were taken and gave a mean sectional area of ·995724 sq. ft. equal to 3·982896 cft. Whence sp. gravity
= $\frac{265}{3983}$ = 66·53 lbs. per cft.

The specific gravity of dry wood was obtained from the mean of two old and well seasoned specimens, and found to be 36·06.

The form factor was obtained by felling 22 trees, taking their girth, height, and weight. The cubic contents were obtained from the weight divided by the specific gravity = $\frac{3756}{66·53}$
= 56·56 cft.

Hence form factor results from $\frac{56·56}{86·92 \text{ (ideal cylinder)}}$ = ·65

The blue gum (*E. globulus*) in the Ceres Road plantation gave similarly good results, the figures being as follows:—

Area 1 acre, 11 years old, planted 5 by 5 ft.

No. of trees 466, containing 3545·66 cft.

Annual acre-increment = 322·33 cft. = 5·75 tons of 56 cft.

Average annual individual increment = ·69182 cft.

Ideal cylinder-volume = 7402·23.

Form factor obtained from 20 trees = 479.

Actual stock = 7402·23 \times ·479 = 3545·66 cft.

Annual acre-increment = $\frac{3545·66}{11}$ = 322·33

Specific gravity = 70·03 lbs per cft. green.

The above acre-increment is considered to be only fair growth for blue gum.

The acre-increment given by the whole of the first crop at Worcester (Cape plantation was as 332 cft. per annum. The coppice regrowth at the age of 5 years gave an acre-increment of 457 cft.

The Stone pine on a farm at Somerset West, calculated as above at the age of 42 years gave an annual acre-increment of

249·9 cft timber = 7·1 tons

50·7 cft. firewood = 1·48 tons,

300·6

8·58

A good deal of drift-sand embankment work is in hand, for instance on the shores of False Bay, where a coast dune similar to that of the Gascon Lands is in process of creation. The grass called Marram (*Ammophila arundinacea*), used in France and Pyp grass (*Ehrharta gigantea*) together with wattles and certain native plants are used for the purpose. The Marram grass appears to be a failure at Port Elizabeth, and may not succeed at False Bay, where the temperature is higher and the rainfall less than in Gascony. Pyp grass seems to be the hardier of the two. The Eerste river reclamation has been abandoned on the score of cost, though the work was quite successful. The Railway used to carry about 1,500 truck-loads annually for a distance of 18 (?) miles at $\frac{1}{2}d$ per ton-mile. The doubling of this rate led to the stoppage, and though the Railway was willing to revert to the old conditions, it has been decided that there is better work to be done than to spend £10 per acre on creating land that will, with a rainfall of 15 inches, not be worth more than 10 shillings per acre. At False Bay, the grass is planted 2 ft. apart in rows 6 ft. apart at a cost of £3 11s. 7d. per acre in some cases, in others it only costs 25 to 30 shillings, plus fencing, if necessary, in each case. Wire fencing here costs about £4 per acre. The system of disposing of town refuse by fixing loose sands with it is a most excellent one, killing two birds with one stone. Unfortunately the cost of carriage soon comes in as a limiting factor. The refuse itself apparently costs about 10 shillings per truck (at Eerste river at any rate) and its distribution on the ground may cost as much or more. There is a large number of plantations and an immense amount of work is being done in sowing and planting. With them, kerosine tins, tarred for preservation, seem to occupy the place of our basket-planting, and give great satisfaction. They also prepare nursery beds by making a solid bed of cement, concrete, gravel or clay, on which the nursery soil is spread to the depth of a foot or so.

Insects and plant diseases sometimes cause great havoc, for instance in the Stone pine, in *Acacia melanoxylon*, which was nearly exterminated 20 years ago by the Dorthesia pest, and therefore cannot be grown pure, &c., &c. This *A. melanoxylon* is what they call blackwood. Indigenous to Australia, its shade-bearing qualities allow it to be now used at the Cape for underplanting and interplanting sparsely stocked areas. In the Nilgiris it could not be grown pure on account of a *Loranthus* parasite.

The following list of indigenous or imported trees may be useful for the purpose of collocating the common and scientific names of a few of the more important species now grown at the Cape.

Botanical name.	Common Name.
<i>Aberia caffra</i> .	Kei apple.
<i>Acacia dealbata</i> .	Silver wattle.
„ <i>decurrens</i> .	Black „
„ <i>melanoxylon</i> .	Blackwood.
<i>Apodytes dimidiata</i> .	White pear.
<i>Callitris arborea</i> .	Clanwilliam cedar.
<i>Curtisia faginea</i> .	Assegai.
<i>Elæodendron croceum</i> .	Safraan.
<i>Eucalyptus globulus</i> .	Blue gum.
„ <i>diversicolor</i>	Karri.
„ <i>marginata</i> .	Jarrah.
<i>Gardenia Rothmannia</i> .	Kaarshout (of the Transkei.)
<i>Ocotea bullata</i> .	Stink-wood.
<i>Olea laurifolia</i> .	Black ironwood.
„ <i>verrucosa</i> ?	White „
<i>Pinus Pinaster</i> .	Cluster Pine.
„ <i>pinea</i> .	Stone „
<i>Podocarpus Thunbergii</i> .	Upright Yellowwood.
„ <i>elongata</i> .	Onteinqua „
<i>Pterocelastrus variabilis</i> .	Kersehout.
<i>Pteroxylon utile</i> .	Sneezewood.
?	Kamassi or Cape or S. African Boxwood.

Of the above, the Clanwilliam cedar, sneezewood, stinkwood and yellow-wood are those of the first and greatest importance. *Kamassi* is not really boxwood, but is alleged to be even superior to it, and the dealers in real boxwood, grown on the East Coast are desirous of prohibiting the use of the term "box" as applied to *Kamassi*. About £1,800 worth of *Kamassi* are sent to Europe annually, some of it in the form of peg-tops.

It is impossible to touch on all the interesting points in the Reports, fires, revenue from game licenses, plantation profits, &c. Cape Town is fortunate in having an area of 8,000 acres situate within 4 miles of the city. There 6 to 8 tons of cluster pine seed are sown yearly and it is expected that if two-thirds of the area is devoted to this purpose, the annual supply of sleepers will reach 1,40,000, thus releasing the Knysna forests from being plundered of good sawyer's timber to be wasted as sleepers. There will be the rest of the area and the waste of the sleepers to supply firewood for Cape Town. The planting of blue gum coppice by land owners is strongly recommended, as it is shown that one acre of blue gum in fair growth can furnish a continuous supply of no less than ten tons dry weight of fuel annually. The cost would be about £ 7 and the profit about £ 15 a year.

The financial aspect of the question hardly concerns us much in India. Mr. Hutchins, however, does not hesitate to declare that it would be easy to make the forests pay off the national

debt of the colony, besides keeping much gold in the colony, and making it at the same time more self-supporting. England pays yearly no less than £14,000,000 for imported timber, *which she could and ought to produce for herself*, but her happy insular position fortunately saves her from climatic consequences. She will not always be able to import to this extent. Other countries are becoming exhausted, and more and more jealous of the remnant. Even if she could always import easily she loses a very honest and hardworking class of population. In Germany there are a million of strong men who live by forests alone, and another 3 millions who live by handling forest produce. In fact 12 per cent. of the population depends on forests. It is thus clear that the utmost urgency attaches to the two questions of increasing the forest area up to 25 per cent. if possible, and of placing that area, as far as possible, in safety from the schemes of political or commercial banditti. No country can be well governed so long as its forests and forest policy lie at the mercy of men who care little, and know still less, about the forest need of the country and who may be one year scheming politicians, next year grasping financiers, and the year after bald-headed philanthropic faddists.

F. G,

An Elephant adventure.

Some time ago I wrote a mild protest against the inordinate amount of science and the poverty of shikar in the *Forester*. I have been congratulating myself on the result ever since as I have enjoyed the articles since published on sport immensely; the letter written long ago in a spirit of levity has now, like a badly-thrown boomerang, smitten the person who launched it, as I have since been thinking that I ought to do something to repay the enjoyment given me by "Zoologist" and others—a tender conscience, alas! All my friends know my unconquerable modesty so it will only surprise my enemies that this short yarn does not set forth one of my many deeds of *derring do*, but only recounts one of the mighty deeds of my best friends—a heroine—my bull terrier.

At the end of the cold weather two years ago I had been having a long day at that intensely interesting and most useful work, conducting linear valuation surveys through the teak

forests of my division, for the purpose of estimating the mature crop in a reserve, of which the area being an unknown quantity, anywhere between 80 and 100 square miles, the result was likely to be one that Americans would like to swear to as accurate. I had just shut my book, told the coolies to dry up and had started on what my hunter said would be a short cut to camp. We had not gone far when I saw fresh tracks of a solitary bull bison, and thinking there would be still time before dark with any luck to come up with him, I told the coolies to go straight back to camp while self and hunter, one coolie and my terrier went after the bison; my hunter had his licensed, best action, non-rebounding lock, single, converted Brown Bess, and went ahead tracking. I had a 12 bore Paradox and came second, the coolie followed some 50 yards behind with the terrier in a leash. The track was like all tracks, and need not be described till after about three-fourths of a mile it entered an old ponzo,* very dense with creepers, each of which seemed to grow a strong hook with which one could catch a salmon, and the *alagah bin* flourished after its kind. In fact an ideal place for a crusty old bull to lie up in; just as we got to the edge my hunter stopped and pointing to the track of an elephant whispered "To-day." I replied "at present we are after bison and I am not going to tackle elephants with a 12 bore Paradox, in this sweet patch a bison is bad enough, it will give an aged parent an excellent chance of getting something out of the Indian Government, my huge balance in the Forest Officers' Provident Fund to wit, so go on." However, we had only gone about 100 yards, very cautiously, when I was startled by a ponderous sigh, we both stopped at once and peering through the undergrowth we saw the immense hind quarters of an elephant about 6 yards off. The huge beast was nonchalantly pouring dust on his back with his trunk and it was this sound which had attracted our attention. The chance was too good to be missed, I signed to the hunter and we crept back to the coolie with the dog, and told the former what was ahead and that he was to wait with the dog and on no account to let her go. I then crept back to where we had seen the elephant; he was still there, but wishing to find a more vulnerable-looking spot than the root of his tail I started crawling round to the side. I had just got a view of a beautiful gleaming pair of white tusks, when I heard a pattering on the dry leaves behind me; looking round I saw my bull terrier, her eyes blazing with excitement, her hair erect, she could see I was after something and wished to get a bite in. In vain I made a grab at her as she went past, but the rest baffles description, I heard a tempest of barks, terrified and prolonged trumpeting, combined with a noise as if a steam mowing machine was at work in that "ponzo," I thought that directly the terrier found her antagonist was a stone or two above her

* Deserted Taungya or temporary cultivation clearing.

fighting weight, she would run back to me, and I imagined her running between my legs, with the enraged tusker in full cry, winning tusks down, and the picture pleased me not. I looked hurriedly round, the Chins had cut every decent tree down—I have since been absolutely orthodox on the subject of yacutting and the destruction of the forests—the biggest tree was a Yamene (*Gmelina arborea*), it had been badly felled and had 3 very decent stool shoots, about 18 inches in girth each. I went up those 3 sticks quicker than a wooden monkey goes up a string in the strand, and my hunter fled up an adjacent creeper, balancing himself between that and a small tree, looking all the world like a Hulu. Then I had the front seat, or rather stand, at a most exciting scene, the tusker seemed terrified and was prancing round like a top, his trunk curled in a tight knot and trumpeting for all he was worth, the terrier making ferocious rushes at him and springing forward to try and get a grip; the tusker would then charge, as the dog retreated dig ferociously at her with his right tusk, the dog of course being by that time a yard further off; this waltz was coming unpleasantly near my three sticks, so I loosed off into the elephant's head, alas, too high, but it started him off away from me like a runaway locomotive and the terrier shrieking with delight went after him, I breathed a sigh of relief, elephant-baiting is the finest bit of excitement to be got in Asia, but next time I want a heavier gun or safer seat; I was just preparing to shin down my coppice shoots when I heard the din rapidly re-approaching; that infernal dog had headed the beast and was snapping along side, the elephant's tusks being pointed straight for my poles. I let drive right and left, Brown Bess roared to my right and the elephant, thank heaven, swerved away to the left, making off this time not to return. We climbed down and after about 5 minutes the terrier turned up, tongue out, fearfully pleased with herself; she had utterly defeated the king of the forest, routed him trunk and tusks. I went back to the coolie, he explained that he had got frightened, climbed a tree and let the dog go, the elephant we never heard of again. After sorrowfully kicking the coolie we returned to camp.

“TA WKWE.”

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Erythrina Indica.

Two late articles in the *Indian Forester* on the geographical distribution of this tree, induce me to say a few words on the subject. As correctly stated by Kurz and Prain, it is a sea coast tree and its home is the Sundarbans, the coast of Burma, of the Andamans and Nicobars, as well as of the Malay Archipelago and Polynesia. Like other sea coast trees, the *Cocoanut*, *Casuarina*, *Thespesia populnea*, it has from time immemorial been cultivated largely in the inland districts of India and Burma, being a fast growing tree easily raised from cuttings, for the support of the Betel vine in the south, and for its showy flowers in the north. In many places it has become naturalized, spread from self-sown seed and hence it is difficult to say whether it actually is indigenous inland. When I wrote the *Forest Flora* in 1873, I was not aware of its being a sea coast tree. I had specimens before me from the districts mentioned but these specimens do not prove that the tree is indigenous inland. It is different with the following definite statements :

1. Kurz, *Forest Flora* I., 369 : dry forests of the Prome district.
2. The anonymous writer in *Indian Forester*, Vol. XXIII. 468 : dry hills of the Prome district in virgin forests, miles away from any village.
3. Mr. Woodrow : in a Bombay swamp.
4. G. M. R., in *Indian Forester*, Vol. XXV. 110 : common in the dry hill forests of the south Thana Forest division, about 50 to 60 miles inland, away from towns and villages, also in the mixed forests of the Tansa lake catchment area.
5. Talbot, *List Bombay* 1894. 71. In the deciduous forests of the Konkan and north Thana.
6. Gamble, *List Darjeeling district*, 1896. 27 : Khair and Sisu forest in the Terai, and banks of rivers in the Lower Hill Forest valleys. Also common in low waste ground near rivers in the Terai.

We will first discuss the Burma localities (1 and 2). Regarding the species Kurz could not have been mistaken. He had thoroughly studied Burmese trees and knew them well. But it does not seem quite certain, whether he gathered the specimens of *E. indica* himself. The anonymous writer in the *Indian Forester* of 1897 may, for all we know, be a great botanist, nay, he may possibly be one of the leading botanists of India. As he has not, however, revealed his name, he must not take it amiss, if we think it possible, that he may have mistaken the species.* As far as I know, there are in Burma four species besides *E. indica*, viz., *E. stricta*, *suberosa*, *ovalifolia* and *lithosperma* all with large scarlet flowers. For *E. holosericea*, Kurz is, as pointed out by Prain, (*Journ. As. Soc. Bengal*, Vol. 66, 11. 72) a mistake, based upon a mixture, leaves of *E. lithosperma* and flowers of *E. ovalifolia*.

It is not likely that *E. lithosperma* (Ye-kathit) should have been mistaken for *E. indica*, for it flowers while in full leaf. In the moist valleys of the Hpyu and Khabaung forests, where it is common, the Betel vine being frequently grown on it, the showy scarlet flowers form a striking contrast to the dark green foliage. *E. indica*, like the other Indian species, is leafless while in flower. *E. ovalifolia* (Kônkathit), according to Kurz, is only found in the tidal forests and in the plains. There thus remain *E. stricta* (Taungkathit) and *E. suberosa*, and one of these may possibly have been mistaken for *E. indica*.

We now come to the Bombay localities, mentioned under 3, 4 and 5. On the west side of the peninsula 2 species only besides *E. indica*, are known. *E. stricta* and *suberosa*. Their characters are so clearly given in Talbot's excellent list, that it is hardly likely a mistake could have been made. The Bombay inland localities in the Thana district, in the Konkan and in North Kanara must therefore for the present be accepted as proof that the tree is indigenous at a distance from the coast in that part of the country. And the same must be said regarding the habitat mentioned by Gamble in the Darjeeling Terai and outer valleys, where he also mentions a second species, probably *E. suberosa*.

For the present, therefore, we may assume that *Erythrina indica* is indigenous in certain inland localities of Pegu, Bengal, and Western India. There are many other trees, shrubs and woody climbers which are commonly regarded as seacoast plants, but which undoubtedly are also indigenous inland. From Professor Schimper's important little work on the seacoast vegetation of India and the Malay Archipelago† I will quote* the following species.

* We have looked up the reference. The anonymous writer was a forester and not a botanist; apparently also he based his assertion on Kurz's authority only, so his evidence may be disregarded.

HON. ED.

† Die Indo-Malayische Strand Flora. Jena, 1891.

1 *Dodonæa viscosa*.—Linn, common on the coast: Sriharikot, Amherst to Mergui and the Andamans. According to Schimper a seacoast species of the Malay Archipelago. Inland, common in the Punjab, Beluchistan, on the Sandstone hills, (Pachmarhi, Bori) south of the Narbada river, the Chanda district, the Deccan, Nilgiris and Pulney hills.

2 *Cæsalpinia Bonducella*.—Fleming (*O Bonduca*, Roxb; Kurz F. Fl. I., 406), a cosmopolitan sea coast species, at the same time undoubtedly indigenous inland in India and Burma.

3 *Mimusops hexandra*.—Roxb. On the coast at Amherst, Sriharikot, but also indigenous inland on the sandstone hills north of Bori and the Chanda district. Schimper mentions other species of *Mimusops* as littoral. The species of this genus are not easily identified.

4 *Vitex trifolia*.—Linn. Sea coast of Ceylon and, according to Schimper, of the Malay Archipelago and elsewhere. Inland, indigenous in Burma and India.

5 *Randia dumetorum*.—Lamk. Coast of Ceylon, Sriharikot, and according to Schimper on the coast of the Malay Archipelago and south China. A common inland shrub of India.

The following I only know as inland species, but Schimper classes them as sea-shore plants of the Archipelago.

Derris scandens, Benth, *Entada scandens*, Benth. and *Woodfordia floribunda*, Salisb. (*W. fruticosa*, Kurz.)

Most species, which have their home on the sea coast, especially of tropical regions, are cosmopolitan, the study of the inland home and the biological characters of their species therefore is interesting and hence I have ventured to draw attention to this subject. As to *Erythrina indica*, more information regarding the inland localities, where it is indigenous, would be interesting, hence I take the liberty, for ready reference, to state the characters by which the different arborescent Indian species of this genus may easily be distinguished.

I. Flowers when leafless, calyx spathaceous.

1. *E. indica*.—Lam., Leaflets entire, glabrous. Calyx 1 in. long, contracted and 5-toothed at the apex. Wings and keel equal, one-fourth the length of standard.

2. *E. stricta*.—Roxb. Leaflets entire, nearly glabrous. Calyx $\frac{1}{2}$ in. long, keel half the length of standard, wings much smaller.

II. Flowers when leafless, calyx campanulate or turbinate, limb truncate, or split into several divisions.

3. *E. suberosa*.—Roxb. Branchlets, underside of leaves and inflorescence densely clothed with long soft, bi—or trifurcate hairs. Leaflets entire or sinuate-lobed. Calyx turbinate, 2-lipped, keel half the length of standard, wings minute.

4. *E. ovalifolia*.—Roxb. Leaflets glabrous elliptic, silvery white beneath. Calyx campanulate, splitting irregularly into 2 or more unequal divisions. Corolla dull purple, standard $1\frac{1}{2}$ in. long, keel 1 in., wings $\frac{3}{4}$ in. long.

5 *E. arborescens*.—Roxb. Leaflets glabrous, from a cordate base broadly ovate, acuminate. Calyx turbinate, limb 2-fid, standard more than twice the length of keel, wings minute. Outer Himalayas, 4000-7000 ft.

III Flowers with the leaves, calyx equally two-lipped.

6 *E. lithosperma*.—Miq. Leaflets glabrous, ovate, acuminate, stipellary glands large, oblong. Lower portion of pod seedless, flat; upper portion shorter, narrower, with 1 to 3 seeds.

D. BRANDIS

The production of Sandal-wood

In the "Forester" for March last, there appeared under the above title a paper to which the Government of India, in connection with the growth of the tree in Coorg, has since directed attention. I do not pretend to such a knowledge of the subject as is possessed by other Forest Officers who have served long in Mysore and Coorg. But I have been studying the question for some little time; and if you can afford me the space, I should wish to discuss some points touched upon in the article, both because the writer did not, perhaps, fully realise the general position as regards sandalwood production, and because others may be tempted to continue the discussion of a question of real interest and importance. In my remarks, I shall confine myself for the most part to the sandal-producing belt of the Mysore plateau. The conditions in Coorg influencing the growth of the species are identical with those obtaining in parts of Mysore. I have little knowledge of the sandal resources of the Madras and Bombay Collectorates bordering on Mysore. The quantities, however, of the wood annually sold by the Forest Departments in these Presidencies appear to be small, ranging from 100 to 200 tons in all. Mysore sandalwood greatly preponderates in the East Indian trade. The State is the natural home of the species; and very probably silvicultural methods or measures of conservancy, successfully applied in Mysore, would be equally successful in the adjoining British districts.

The article of March maintains that there are as yet no fixed opinions as to the best means of assuring a sustained yield; that the proposal to allow the holders of revenue-paying lands to participate in the profits derived from sandal growing on their fields is Utopian and not likely to foster the reproduction of the species; that the attempt to raise sandal in regular plantations should not be abandoned; and that the tree should be introduced by seed-dibblings throughout reserves suitable for its reception.

To the last proposition no objection seems possible, provided artificial (as opposed to natural) sowings are required at all. For, so far as my experience goes, wherever, in the comparatively narrow sandal-bearing belt of country, a forest is

really suited to the growth of the species and can be protected from cattle and fire, there will the tree be present, plentifully-seeding and reproducing itself naturally. Nature, aided by the severe penalties for sandal destruction enforced during the last 100 years and more, appears long ago to have introduced the species into all the areas best suited to the tree. No doubt there are tens of thousands of acres, coffee estates and arable lands, where the species once thrived but no longer exists and where it could easily be propagated. But I venture to think that, given a strictly conserved forest, *apparently* well suited to sandal, yet in which sandal has never grown in natural conditions, efforts to grow fine trees are most unlikely to succeed. One of the most marked characteristics of the species is the contrast between the robustness of its habit and the readiness with which it reproduces itself under natural conditions and its sensitiveness to human intervention of any kind. Thus, self-sown seedlings may be observed growing like weeds in garden pots containing flowering and foliage plants. Yet experience shows that had seed, from the same parent trees, been simultaneously and carefully sown by hand, the results would not have been so good. There are exceptions, of course. Nobody has asserted that sandal cannot be grown from hand sowings or plantings. The species has been introduced with admirable results *so far* into the casuarina plantations. But ultimate success cannot be predicted with any confidence. The conditions of growth in the plantations are, as I propose to show, both abnormal and temporary. Everything is in the experimental and transition stage. Mature sandal from hand sowings does not, it is believed, exist in India; and we know that sandal, on the Mysore tableland, is never found growing naturally under the conditions in which, with less or greater success, we have been attempting to make it grow in the regular plantations.

In discussing the future of sandal, the writer of the article aforesaid deals with the three following sources of supply:—

(a) Trees near cultivation, in hedgerows, on grazing grounds or private lands:

(b) Trees in reserves grown either naturally or by cultural operations aiding natural reproduction; and

(c) Trees in regular plantations. To these I would add;

(d) Trees in the extensive district (*i. e.*, nominally protected) forests and in all waste lands, the property of Government.

Now, the writer of the March article, while admitting (a) to have been an important source of supply in the past would not rely on it for the future. But his premises were, in some degree, mistaken, and it seems to me that his conclusions can be reasonably objected to. Why should not this source of supply be as important in the future as in the past? Unquestionably I think because, at the close of the nineteenth century, the Government sandal monopoly, as at present enforced over private

lands, is an anachronism and the people will not tolerate it much longer. A century or so ago, when there were no village schools, and when Tippoo is stated to have punished sandal damage with the loss of a limb (including sometimes the head) the position may have been intelligible and defensible enough. But at the present day the ryot has no longer the same reverence for the sandal tree. If he allows a seedling to persist and grow up he incurs the liability of protecting it and of answering for all damage done to the tree. If he successfully protects the tree, what does the Government give him in return? Nothing. Under the present rules, the ryot is permitted to remove by the plough, in *bonâ fide* cultivation, seedlings less than three feet in height. But he is naturally careful to remove as well seedlings growing in his hedges and enclosures and there is at present no practicable means of hindering him from doing so. He now fully realises the onerous and one-sided nature of the monopoly; and the consequence is that unless there be a change of practice, sandal in private holdings will soon become rare and eventually extinct. The article treats of a proposal to induce the ryot to raise or protect sandal trees by promises of payment 50 or 60 years hence, and assumes, if I properly understand, that areas under class (a) are, or will be "roamed over by cattle and goats, where the plants run the constant risk of being eaten or being burnt by jungle fires and of being hacked down by the villagers." No wonder, then, that the project of growing sandal under (a) was treated as chimerical! There is, however, no question of inducing a ryot to do something by offering to pay money to his posterity. He would, like most people, greatly prefer cash down, and that is what was proposed; namely, to grant, in Coorg, a ready-money and sufficiently liberal payment based on the estimated value of each tree uprooted. If a 10% payment be made (thus reducing the nett profit to Government from 90% to 80%) the ryot would have every inducement to grow and to protect sandal. A few good trees would pay for his land assessment several times over. He clearly would not "hack down" anything so valuable to him. Fires do not overrun private lands and neither, generally speaking, do cattle and goats. It is in fact almost as easy for the ryot to raise and to protect, as it is for him to destroy, sandal in his holding. Those who have local experience, foresters, district officials, planters and others, appear to be of this opinion and to agree in thinking that, in default of a ryot's share, there will soon remain few trees on private lands. Trustworthy evidence on the point would be easily procurable in the Civil and Military Station of Bangalore, where the monopoly is in full force. When advocating the grant of a share to Coorg ryots, I was unaware that the late Conservator of Forests in Mysore had moved in the same direction and that, in 1875 under British rule, orders had actually been issued to allow the ryots to participate in the profits. The rules, however, were not put in force, and the Chief

Commissioner asked the Government of India to cancel them on the grounds, amongst others, that they "*would be productive only of embarrassment and difficulties, and that they would afford considerable facilities for fraud against Government, whose monopoly of the sandalwood is adequate to secure its interests, so far as regards the preservation in localities where its growth is free and unimpeded.*" (The italics are mine). But the Government of India demurred, thought the rules were a move in the right direction, and in their letter (No 875, dated 7th September 1867) which has been published, went on to say like a true prophet:—

"You say that the Government monopoly of sandalwood is adequate to secure the preservation of that existing in occupied lands, and that the proposed rules would add considerably to the present heavy duties of Amildars of taluks and village officers, while in your opinion it is extremely doubtful whether they would work efficiently in practice. But it appears to His Excellency in Council that the fact of there being a Government monopoly cannot alone be expected to suffice for the protection of the seedlings and young trees. It is understood that the sandalwood grows best on fields and in hedgerows, and it is obviously the interest of the ryot rather to destroy than to preserve the trees growing on or near his fields. It seems unlikely that the fear of penalties would prevent the occupant of the land from destroying seedlings and young trees, when he could do so with very little chance of being detected, and it appears to be more than probable, that as the ryots become year by year more alive to their own interest, the number of trees in the hedgerows will decrease. The notification issued by Sir Richard Meade tends to give the ryots a pecuniary interest in the protection of the young sandalwood trees in their fields, and it seems to the Governor General in Council that their preservation is more likely to be secured by the hope of reward than by the fear of penalties."

Nevertheless, the rules were subsequently cancelled. The objections taken, to them locally, appear to have been founded more on administrative difficulties anticipated in their application, than on the principle involved. In any case, circumstances have greatly changed for the worse in the course of the last 25 years, and nobody with local knowledge can any longer suppose that the monopoly is sufficient to safeguard the preservation of the species. Whether the rules of 1875 will be re-introduced in a modified form is doubtful. There are very extensive areas of Government sandal-producing forests which, under an improved system of protection and working, may possibly suffice to meet all requirements. But I am confident, to paraphrase your article of March last, that the justification for the concession to the ryot would be the "certain expectation" that reproduction would

improve and that the future supply of wood thereby be increased. The only question at issue, it seems to me, is whether the ryots would not grow more sandalwood than could ultimately be absorbed by the market. I would leave this side of the question with the remark that *in present circumstances*, the only areas, with few exceptions, where sandal will grow well naturally, and where at the same time it can be adequately protected, are private lands.

Next as to (b) sandal trees in reserves, grown naturally or by cultural operations, there can presumably be no doubt as to the good policy of fostering the growth of the species in reserved forests where protection can be assured and where soil and climate are suitable. But where are such reserves to be found? When about 1860, forest conservancy first received attention, and subsequently, the policy was to take up and reserve forest tracts as free as possible from rights of user, and containing timbers valuable for construction, such as teak and rosewood. These forests never did nor could contain sandal, which it was thought might be left to take care of itself in virtue of the monopoly. Until recent years little effort appears to have been made to constitute reserves in the submontane and plains country comprised in the sandal-bearing belt. But the advisers of the Government of India seem, for a number of years, to have entertained doubts as to the future of sandal and from time to time they uttered warning notes as, for instance, in 1880 when it was suggested that "open jungles" where the natural tree exists should be reserved in Coorg. But the Indian Forest Department severed its connection with Mysore about that time and the question of future supply has since not been so fully considered. During many years no forest, either in Mysore or Coorg, appears to have been reserved mainly in connection with sandal growth. At the present day, in the sandal belt, cultivation has been extended, all kinds of forest rights or users have arisen; and in both provinces the constitution of sandal reserves is no longer the comparatively simple matter that at one time it apparently might have been. There are several examples, however, on the Mysore plateau which conclusively prove what might be done for sandal by taking up "open jungles," where the tree grows naturally, by limiting conservancy to fire-protection and the regulation of cattle grazing. A notable object lesson is afforded by the Devarayadurga State forest in the Tumkur district, mentioned at page 66 of Sir D. Brandis' Report on Forest Administration in the Madras Presidency. This area has, with the exception of a small fire in 1882, been continuously fire-protected since 1868, and the pasturage of cattle has been consistently regulated. In considerable portions of the forest sandal grows luxuriantly, with tall stems carrying the girth well up. The tree reproduces itself freely and, owing to the protection afforded and to the presence of suitable cover, dibblings of seed have given remarkably good

results. The principal species associated with the sandal are Albizzias, Acacias, Cassias, *Ziziphus (xylopyra and Oenopia)*, *Erythroxylon monogynum*, *Canthium parviflorum*, *Premna tomentosa*, *Wrightia tinctoria* and *Dendrocalamus strictus*. The question even arises whether the conservancy, so far as a sandal is concerned, has not been too good, as the general tree-growth appears in places to be too dense. But this defect can, without difficulty, be remedied by thinning out relatively valueless stems where the sandal has attained sufficient height of bole and is, therefore, no longer in need of special protection, except, of course, from fire. The main point is that in this forest, and in other areas naturally suited to sandal and similarly circumstanced (unhappily there are very few), the tree grows freely and healthily, simply because sufficient protection is assured to it.

Turning to (c), Trees in Regular Plantations, your article suggests that, before the plantations are condemned, it should be ascertained whether comparative failure is due to cultural mistakes in planting, &c, or to the absolute inadaptability of the tree to regular plantations. In this connection the following propositions will perhaps be accepted as correct. (1) For many years, planting in "regular plantations" has been tried with great care under a variety of conditions and by different Officers of experience, some of whom have devoted years to the work in Mysore and Coorg. (2) The "regular plantations" have been costly. (3) They have as a whole so far given no definite results from which a probability of ultimate success, if the operations are persisted in, can be foretold. (4) Many of them have utterly failed or are at present in an unpromising condition. (5) Nowhere in India can self-sown sandal be found growing naturally in conditions approximating to those obtaining in the "regular plantations". (6) It has not been shown that regular plantations are economically necessary in view of the sandal trade generally.

The continuance of regular plantations will not presumably be advocated simply in order to prove eventually and at a great cost whether sandal can or cannot be healthily grown in such circumstances. The justification for plantations must be, it is thought, a well-founded presumption that the operations are really necessary if the sandal supply is to be maintained and that they will ultimately be profitable. But has that test been applied to them, can their continuance be deemed necessary and indeed is planting under any circumstances required at all? I think not; or at least that planting ought not to be necessary if proper means were taken to provide for the natural growth of the tree. I write of the sandal-bearing belt in Mysore, not of Coorg. In Coorg the sandal area is relatively of very small extent and the conditions influencing reproduction are more unfavourable than in Mysore generally. Probably in Coorg artificial reproduction by dibblings in suitable areas suitably protected (if any such can be found) will be expedient; the more so as Coorg is a separate

competitor in the matter of sandalwood sales. But, taking the sandal country as a whole, the continuance of regular plantations, even if promising well, would I think be open to question. Plantations other than those classed as "regular," into which sandal has been introduced at a nominal cost, are much more promising and, on the score of expense also, cannot be regarded in quite the same light. The cheap introduction of the species into the casuarina plantations has so far been successful to a degree which appears phenomenal judging from the results secured at so much greater a cost in Coorg. The casuarina trees seem to be ideal nurses to the young sandal plants which were dibbled in at their bases and which in many areas are healthy and growing rapidly. In some cases the sandal growth is so rapid as to overtake that of the casuarina planted previously. Thus I recently measured a sandal tree 12 years old, girthing 18 inches and not less than 35 feet high. The casuarina trees immediately adjoining, planted in 1887, were slightly smaller. Nothing could look more promising. But, as has been pointed out in the article of March, the problem will be to maintain conditions suited to sandal as soon as the time comes, as it very soon will come, to remove *all* the casuarina trees. The casuarina is not suited to the Mysore plateau where the tree grows slowly and dies when young (at from 15 to 25 years of age). The purpose for which the plantations were formed no longer exists, and from a monetary point of view replanting is inadvisable. One difficulty is that while the casuarina fails to reproduce itself naturally the introduction under its shade or in conjunction with it of indigenous trees or shrubs is no easy matter. Endeavours to secure the desired mixture are now being made, and on their result the persistence in good health of the sandal will probably depend. The curious point is that the sandal, which is all young and quite immature, is growing really well under conditions never naturally found on the Mysore tableland. We should probably, however, not be justified at present in drawing, as the writer of the article in the March number would do, conclusions from the casuarina-cum-sandal combination, and in applying those conclusions for the introduction of the sandal tree into all suitable reserved areas.

Lastly, comes (*d.*) sandal in district forests and other Government waste lands. The areas included in this category are very extensive. They comprise by far the greater part of the sandal belt, excluding village common lands and cultivated holdings. Their extent, so far as sandal is concerned, is not known. Much of their total area is not under the management of the forest department, and a further portion, although nominally subject to certain rules of conservancy, is really not protected in any way. All the sandal-bearing lands in this class are subjected to firing and cattle-grazing without any restriction. There is no doubt that sandal is disappearing from firing and other causes more or less preventible, the annual

loss of valuable wood is very great. Probably the total annual loss is not less than $2\frac{1}{2}$ lakhs of rupees of what may be called sandal revenue-producing capital value. Measures are contemplated, which it may be hoped, will not merely lessen the annual loss but will much increase the growing stock of sandal trees. The bearing of the management of these lands on sandal production in future is very important. Already, in some parts of the country, the fixed annual sale of wood is not collected so easily as once was the case; and this is the more significant when it is remembered that only dying or dead stems are supposed to be uprooted. How many have died from natural decay and how many have been killed by fire or other injury is unknown. The main supply of wood has hitherto always been drawn from these areas (class *d*) or from private lands (class *a*). The condition and prospects of both classes as regards future supply appear to be about equally unfavourable. But while, as has been shown, an effective remedy could be applied to class (*a*), the efficient protection of class (*d*.) will certainly be much more difficult and, in the cases of some forests, may be impossible.

What is the average annual average outturn of Indian sandal-wood. Taking Mysore first, the average annual quantity of heart-wood sold during the 10 years ending with 1894-95 was 2,200 tons, yielding Rs. 7,87,000. The previous and subsequent sales were, however, somewhat less. In 1898-99 the quantity was 2,061 tons yielding Rs. 7,86,000. Arrangements are annually made for the sale of 2,000 tons; and this figure may be taken as the annual demand on the Mysore forests. In Coorg, during the decade ending 1897-98, the average yearly sale was 118 tons yielding Rs. 47,600. An enquiry instituted in 1896 showed that, from 1890-91 to 1894-95 inclusive, the average yearly transactions from all sources amounted to 2,372 tons, the excess above the Mysore-Coorg output being attributed to sales of wood in districts of Madras and Bombay and to small imports from abroad. The total annual demand may perhaps be taken at 2,300 tons, of which 2,000 tons are furnished by Mysore. About one-half of the wood is exported to China, Egypt, European ports and to the United States. Whether the foreign demand, so far as wood for oil distillation is concerned, will be maintained, is an open question. Oil distillation has been started in Western Australia, where an abundant supply of the wood (*S. Cygnorum*) is stated to be obtainable, and large quantities of Macassar and Venezuela oils have been latterly distilled. Competition to secure a cheap product is keen, and small quantities of West Indian oil have, for that reason, recently been even imported into this country. Analyses, however, have proved the incontestable superiority of the East Indian product, and it may therefore be hoped that foreign competition will not permanently affect our export trade.

The question arises : can an annual supply of some 2,300 tons of wood be assured ? I believe it can be assured by ordinary measures of protection and without resort to costly plantations. It is simply impossible to adduce at present statistics of value in support of this opinion.* The exact area of forest and other land capable of yielding good sandalwood is not known but is certainly great, relatively to the demand for wood. The tree census, which has been in progress for some years, is not reliable. Even admitting the returns to be accurate, the prevalence of forest fires and other damage is such that the figures are useless, or almost so, in estimating what the condition of the stock will be 20 or 15 years hence. It seems probable that much, if not most of the annual demand of 2,300 tons might be regularly furnished from assessed lands alone if the occupiers be given a personal interest in the costly wood. It is also certain that by the suppression of fires throughout the sandal-producing district forests and Government grazing *kavals* the natural supply of the wood would be largely increased. There are lastly the reserved forests which, though relatively of small extent, are important. Taking the resources of the sandal-bearing belt as a whole, it is difficult to conceive of them as unable to furnish so small a quantity as 2,300 tons of wood annually if measures are taken to protect and increase the natural spread of the species. But if such measures are not taken, it would I think, bearing in mind what is going on, be unreasonable to expect that the present outturn can be very long maintained.

To maintain and, if desirable, to increase, that outturn a radical change of practice appears necessary. It is no longer possible to suppose that the monopoly safeguards the existence of the trees or that sandal forests may be fired or subjected to unrestricted cattle grazing with impunity. The case lies in a nutshell. Sandal will grow freely if protected from cattle and especially from fire: if not so protected it cannot thrive and must in the long run become extinct. The change of practice, it seems to me, should comprise (a) the grant to the ryot of a share in the value of all sandal uprooted from his land for sale by Government; (b) the constitution of reserved forests out of such portions of the district forests and grazing lands as are not burdened with many private rights or privileges, and the application to

* Since the above was written, a map, prepared in connection with the Paris Exhibition, indicates that the total area of the principal sandal-bearing tracts in Mysore is about 5,450 square miles. The largest belt, running from the north-west to the south-east of the province, is about 240 miles in length with a mean width of about 16 miles. The approximate area over which sandal trees have so far been enumerated is now returned at 2,722 square miles. The number of trees enumerated between January 1896 (when the work was begun) and March 1899 is as follows :—

Dead trees ...	78,459	Mature trees ...	5,94,521
Decaying trees ...	1,39,380	Young trees ...	18,65,364

The system of enumeration is faulty in various ways, and the figures are not to be relied upon.

the reserves of strict rules for the prevention of fire and the regulation of grazing; and (c) the prevention of fire by every possible means in the remaining sandal-bearing district forests and waste lands. To carry out (a) seems to be a relatively simple matter; and it is not easy to understand in what direction the measure would endanger the monopoly enjoyed by the Mysore Government. Machinery to efficiently carry out (b) and (c) does not at present exist but will, it is hoped, be provided ere long. I have personally no doubt that were such a change of practice as has been outlined introduced and vigorously persisted in we should hear no more of the sandal supply being endangered.

I refrain from entering in detail into questions connected with the cultivation of sandal. The young plants certainly will not as has been pointed out, stand "drip." The tree in all stages of growth except the youngest (say up to 10 years of age) seems to thrive best in nature when its crown is as free as possible and when good lateral protection is given to the stem. In default of lateral shade the young or half-grown tree often assumes a bush-like growth, especially in poor and mediocre soils, and this greatly decreases its value. Possibly the idea that sandal likes the soil at the roots covered is due to the fact that a tree surrounded, as is often the case, by a low-growing thorny bush is protected from cattle and indirectly, from fire. It has been noticed in some localities that the cattle eat up the grass immediately adjoining the bush, where the fodder is presumably of slightly better quality, and thus create a kind of fire trace. The hardiest and the best oil-producing sandal trees may be observed, with an admixture of other trees and shrubs, in poor, gravelly, well-drained often ferruginous soils: the finest, so far as outward appearance goes, in hedge-rows (allowing a free head and lateral shade) or in well-protected forests, such as that of Devarayadurga already mentioned. But totally different conditions are found in the casuarina plantations in which sandal is doing so well and which therefore are to some people, a kind of sylvicultural puzzle.

J. L. PIGOT.

The Ballad of the Railway Sleepers.

How do the sleepers
Go down to the plains ?
I went to discover this
Once on a time :
And blessed with some leisure,
I'll tell you in rhyme,
Up on the mountains
So blue and so far
They are felling the cedars
And stout deodar,
For yearly in Delhi
The Managing Staff

Demand good sleepers,
A lakh and a half,
For their metre gauge railway
Which via Ajmere,
Bears back the exile
Toward England dear.
The sawyers have shaped them
With axe and saw
Six feet of length
Without knot or flaw.
And the coolies have borne them
A mile or so
Down the steep home
Of the buck and doe.
Another mile
Round the mountain side
On a man-pushed tramway
The sleepers ride.
Hence to the plain
How shall they go ?
For its still six thousand
Feet below.
Here down the steep
Is a sledge-car road
Fifteen sleepers
Make a load.
Give them a push
And away they fly
A hundred feet
In the twink of an eye.
Or if you prefer it
On wire of steel
They can cross a valley
With even keel,
For twenty seconds
Flying there
Through twice seven hundred
Feet of air.
Now they meet
An aqueduct
Neatly against
The mountain tucked;
Breadth ten inches,
Joining strong,
Downwards ever
It leads along.
So let water
Do its part,
Throw them in
And give them a start.
Sometimes swift.
And sometimes slow
With the water,
Along they go.

Here at length,
 They reach the shoot.
A thousand feet
 From top to foot.
See the water
 Leap and gush
Startled out
 By their downward rush ;
Once again
 On a gentler grade
On they speed
 Through the forest shade
Now they're nearing
 The valley bed
Stream of the Kulni
 Watershed
Over the stage
 Like boys at school
In they plunge
 To a limped pool
Now beware
 Of an awkward block,
Full six miles,
 Of shallow and rock.
Line the sides
 With built-up sleepers
And make the channel
 Narrow, but deeper.
Then when the rest
 Of the army's gone
Pull down the sentries
 And pass them on
Yet twice the moon
 Must wax and wane
E're the stream assumes
 Its wont again
And the last of the fifteen
 Myriad hoard.
Launches forth
 On the river broad.
So from Kulni to Tons
 And Gons to Jumna
Sails the mountain's
 Late alumna:
Past the Siwaliks
 And through the plains,
Till the Delhi ramparts
 At length it gains,
Now take it over
 You Railway lot ;
Let the sleeper sleep
 In its ballast cot.

Lay it to rest,
(It has travelled far)
In the permanent way
Of the R. M. R.

E. F. E. W.

EXTRACT FROM THE IMPERIAL INSTITUTE JOURNAL.

REPORT ON THE RESULTS OF MECHANICAL TESTS APPLIED TO A
SERIES OF LOGS OF TIMBER RECEIVED FROM THE CEYLON

GOVERNMENT.

(By Professor W. C. UNWIN, F. R. S., *Referee to the Scientific and Technical Department of the Imperial Institute.*)

The whole of the samples (22 in number) were in a dry and well seasoned condition, but some of them had serious drying cracks or shakes. No. 8 sample (Mandora), and No. 20 (Halmilla) have a good elastic range. No. 13 is an exceptionally light timber and—as would be expected—of relatively low strength. On the other hand, No. 22 (Hedun) is a very heavy timber of relatively great strength. No. 16 (Chomunti) is rather heavier than No. 22, but its strength is not so great.

No. 14 (Walukina) is a rather light timber of good strength.

The following tabular statements give :—

- (1) The heaviness of the timbers ;
- (2) Their resistance to shearing along the fibres ;
- (3) The crushing strength ;
- (4) The transverse strength ;
- (5) The deflections observed in the bending tests ; and
- (6) The co-efficient of elasticity from the bending tests.

TABLE I.—HEAVINESS.

No. of Specimen.	Name of Timber.	Locality.	Weight of Timber in pounds per cubic foot.
1 (c)	Sapu	Ceylon	41.75 } mean
	"	"	41.70 } 41.41
2 (c)	Panah Ka	"	55.06 } 54.68
	"	"	54.66 }
3 (c)	Gurukina	"	63.02 } 62.62
	"	"	62.23 }
4 (c)	Vuinanku	"	40.58 } 40.41
	"	"	40.24 }
5 (c)	Satinwood	"	64.66 } 64.32
	"	"	63.98 }
6 (c)	Milla	"	60.81 } 60.92
	"	"	61.03 }
7	Hauthai	"	48.87
8	Mandora	"	59.70
9	Ubbriya	"	56.71
10	Jawenna	"	46.11
11	Dawata	"	47.33
12	Margosa	"	47.32
13	Lucumidella	"	20.39
14	Walukina	"	32.41
15	Ranai	"	63.31
16	Chomunti	"	75.46
17	Suriya	"	50.33
18	Jak	"	43.37
19	Del	"	48.09
20	Halmilla	"	49.93
21	Suriya Mara	"	57.01
22	Hedun	"	70.79

TABLE II.—RESISTANCE TO SHEARING ALONG THE FIBRES.

No. of Specimen.	Name.	Locality.	Area sheared. Sq. in.	SHEARING STRESS.	
				Pounds per sq. in.	Tons per sq. in.
1 (f)	Sapu ...	Ceylon.	4.010	753	0.3359
2 (f)	Panah Ka ...	"	3.960	745	0.3325
3 (f)	Gurukina ...	"	3.999	948	0.4231
4 (f)	Vuinaku ...	"	3.960	486	0.2170
5 (g)	Satinwood ...	"	3.999	1,903	0.8496
6 (g)	Milla ...	"	4.100	1,147	0.5116
6 (f)	" ...	"	4.240	880	0.3936
6 (h)	" ...	"	4.000	984	0.4392
7	Hauthai (1) ...	"	4.120	1,013.4	0.452
8	Mandora (2) ...	"	3.984	620.4	0.277
9	Ubbriya (1) ...	"	4.041	1,066.6	0.476
10	Jawenna (3) ...	"	4.036	1,083.7	0.484
11	Dawata (5) ...	"	3.880	1,075	0.480
12	Margosa (4) ...	"	3.835	1,326.0	0.592
13	Lucumidella (6) ...	"	3.901	478	0.213
14	Walukina (1) ...	"	4.696	336.9	0.150
15	Ranai (5) ...	"	3.821	925	0.413
16	Chomunti (5) ...	"	3.940	1,333	0.595
17	Suriya (1) ...	"	3.862	926.9	0.414
18	Jak (5) ...	"	3.881	672	0.300
19	Del (7) ...	"	3.744	1,236	0.551
20	Halmilla ...	"	4.028	830.3	0.371
21	Suriya Mara (7) ...	"	3.880	1,283	0.572
22	Hedun (5) ...	"	3.920	1,486	0.663

- (1) Nearly plane fracture. (5) Fairly plane fracture.
 (2) Rather ragged fracture. (6) Broke partly by tension.
 (3) Irregular fracture, small knot. (7) Very irregular fracture.
 (4) Irregular fracture.

TABLE III.—CRUSHING STRENGTH.

No. of Specimen.	Name.	Locality.	DIMENSIONS IN INCHES.		Area of crushed section. Sq. ins.	Crushing stress. Tons per sq. in.
			Section.	Height.		
1 (c)	Sapu ...	Ceylon.	3.049 × 3.057	8.130	9.320	1.570 (5)
2 (c)	Panah Ka ...	"	3.157 × 3.159	8.075	10.020	2.768
3 (c)	Gurukina ...	"	3.061 × 3.034	8.085	9.285	2.408 (5)
4 (c)	Vuinaku ...	"	2.892 × 2.874	7.984	8.312	1.932
4 (d)	" ...	"	2.891 × 2.892	8.057	8.360	1.942
4 (e)	" ...	"	2.917 × 2.876	7.987	8.389	1.927
5 (c)	Satinwood ...	"	3.151 × 3.166	8.008	9.974	3.374
6 (c)	Milla ...	"	2.890 × 2.925	8.007	8.453	3.118
7	Hauthai (2) ...	"	3.100 × 2.672	8.146	8.283	2.778
8	Mandora (1) ...	"	3.194 × 3.068	8.139	9.799	2.619
9	Ubbriya (1) ...	"	3.033 × 3.026	8.140	9.178	3.433
10	Jawenna (3) ...	"	3.043 × 3.034	8.152	9.232	3.454
11	Dawata (1) ...	"	2.879 × 2.862	8.034	8.240	2.670
12	Margosa (1) ...	"	3.086 × 2.437	8.171	7.706	2.987
13	Lucumidella (1) ...	"	2.872 × 2.850	8.037	8.166	1.358
14	Walukina (4) ...	"	2.910 × 2.819	8.026	8.203	2.743
15	Ranai (2) ...	"	2.863 × 2.888	8.015	8.268	2.605
16	Chomunti (1) ...	"	2.913 × 2.867	7.974	8.351	2.938

TABLE III.—CRUSHING STRENGTH. —(Concluded.)

No. of Specimen.	Name.	Locality.	DIMENSION IN INCHES.		Area of crushed section. Sq. in.	Crushing stress. Tons per sq. in.
			Section.	Height.		
17	Suriya (4) ...	Ceylon.	2.976 × 2.833	8.036	8.420	2.818
18	Jak (2) ...	"	2.897 × 2.873	7.910	8.323	3.400
19	Del (1) ...	"	2.896 × 2.869	7.925	8.308	2.932
20	Halmilla ...	"	3.012 × 2.996	8.146	9.024	3.442
21	Suriya Mara (1) ...	"	2.881 × 2.851	8.012	8.214	4.184
22	Hedun (1) ...	"	2.884 × 2.851	7.933	8.222	3.919

(1) Gave way by shearing.

(4) Split along the grain.

(2) Gave way by shearing and splitting.

(5) Knot in specimen.

(3) Split before testing. Gave way by shearing.

TABLE IV.—TRANSVERSE STRENGTH.

No. of Specimen.	Name.	Locality.	DIMENSION IN INCHES.		Span Ins.	Centre Break-ing Load Pounds.	Co-efficient of Trans-verse Strength.	
			Breadth	Depth			Pounds. per sq. in.	Tons per sq. in.
1 (a)	Sapu ...	Ceylon.	2.925	3.378	42	4,000	7,551	3.370
1 (b)	" ...	"	2.924	3.387	42	4,320	8,078	3.606
...	...	...	...	...	...	Means	7,815	3.488
2 (a)	Panah Ka ...	"	2.915	3.378	48	5,860	12,690	5.661
2 (b)	" ...	"	2.919	3.383	48	6,140	13,230	5.907*
...	...	...	...	...	...	Means	12,960	5.734
3 (a)	Gurukina ...	"	2.909	3.378	48	4,980	10,800	4.820
3 (b)	" ...	"	2.920	3.385	48	3,100	6,673	2.979
...	...	...	...	...	...	Means	8,737	3.900
4 (a)	Vuinaku ...	"	2.914	3.387	48	4,455	9,596	4.284
4 (b)	" ...	"	2.853	3.369	48	4,240	9,432	4.210
...	...	...	...	...	...	Means	9,514	4.247
5 (a)	Satinwood ...	"	2.914	3.381	48	5,840	12,630	5.635
5 (b)	" ...	"	2.916	3.375	48	6,890	14,930	6.665
...	...	...	...	...	...	Means	13,700	6.150
6 (a)	Milla ...	"	2.912	3.376	48	6,780	14,710	6.564
6 (b)	" ...	"	2.919	3.363	48	6,790	14,810	6.612
...	...	...	...	...	...	Means	14,760	6.588
7	Hauthai ...	"	2.873	3.274	40	4,000	7,793	3.479
8	Mandora ...	"	2.859	3.287	40	7,060	13,710	6.125
9	Ubbriya ...	"	2.886	3.299	40	5,285	10,090	4.505
10	Jawenna ...	"	2.868	3.282	40	4,154	8,068	3.602
11	Dawatta (1) ...	"	2.875	3.275	40	5,560	10,815	4.83
12	Margosa ...	"	2.865	3.286	40	5,921	11,480	5.125
13	Lucumidella (1) ...	"	2.842	3.268	40	2,890	5,720	2.55
14	Walukina ...	"	2.814	3.259	40	4,490	9,014	4.024
15	Ranai (1) ...	"	2.868	3.273	40	5,410	10,565	4.71
16	Chomunti (1) ...	"	2.861	3.231	40	7,210	14,485	6.46
17	Suriya ...	"	2.859	3.262	40	5,913	11,660	5.206
18	Jak (2) ...	"	2.872	3.270	40	3,500	6,839	3.053
19	Del (1) ...	"	2.871	3.284	40	4,806	9,307	4.155
20	Halmilla (1) ...	"	2.844	3.090	40	6,995	15,450	6.898
21	Suriya Mara ...	"	2.869	3.238	40	7,322	14,600	6.518
22	Hedun (1) ...	"	2.850	3.059	40	7,130	16,040	7.161

* Broke by shearing and tension. (1) Broke by tearing on tension side.

(2) Split diagonally along the grain.

MECHANICAL TESTS OF TIMBER.

TABLE V. — DEFLECTIONS OBSERVED IN THE BENDING TESTS.

No.	Deflection.	Centre Load, Pounds.														
		0	500	1,000	1,500	2,000	2,500	3,000	3,500	4,000	4,500	5,000	5,500	6,000	6,500	7,000
			Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.
1 (a)	Increment of ...	0	0.078	0.078	0.074	0.072	0.064	0.084	0.028							
	Total ...	0	0.078	0.166	0.230	0.302	0.366	0.450	0.478							
1 (b)	Increment of ...	0	0.096	0.078	0.084	0.122	0.010	0.082	0.086	0.176						
	Total ...	0	0.096	0.174	0.208	0.330	0.340	0.422	0.508	0.684						
2 (a)	Increment of ...	0	0.092	0.086	0.074	0.080	0.082	0.068	0.086	0.100	0.200					
	Total ...	0	0.092	0.178	0.252	0.332	0.414	0.482	0.568	0.668	0.958					
2 (b)	Increment of ...	0	0.119	0.089	0.060	0.132	0.070	0.074	0.056	0.124	0.140	0.276	0.268	0.332		
	Total ...	0	0.119	0.208	0.268	0.400	0.470	0.544	0.600	0.724	0.864	1.140	1.408	1.740		
3 (a)	Increment of ...	0	0.100	0.080	0.068	0.092	0.060	0.100	0.116	0.132						
	Total ...	0	0.100	0.180	0.248	0.340	0.400	0.500	0.616	0.748						
3 (b)	Increment of ...	0	0.111	0.080	0.080	0.076	0.112									
	Total ...	0	0.111	0.191	0.271	0.347	0.459									
4 (a)	Increment of ...	0	0.140	0.108	0.098	0.148	0.142	0.200	0.188	0.734						
	Total ...	0	0.140	0.248	0.346	0.494	0.636	0.836	1.024	1.758						
4 (b)	Increment of ...	0	0.140	0.132	0.116	0.130	0.138	0.164	0.680							
	Total ...	0	0.140	0.272	0.388	0.518	0.656	0.820	1.500							
5 (a)	Increment of ...	0	0.100	0.070	0.086	0.084	0.074	0.094	0.100	0.082	0.138	0.146	0.214			
	Total ...	0	0.100	0.170	0.256	0.340	0.414	0.508	0.608	0.690	0.828	0.974	1.188			
5 (b)	Increment of ...	0	0.086	0.074	0.040	0.140	0.066	0.060	0.072	0.072	0.076	0.100	0.114	0.080	0.180	
	Total ...	0	0.086	0.160	0.200	0.304	0.370	0.430	0.502	0.574	0.650	0.750	0.864	0.944	1.124	
6 (a)	Increment of ...	0	0.096	0.092	0.078	0.080	0.076	0.082	0.040	0.142	0.062	0.152	0.092	0.150		
	Total ...	0	0.096	0.188	0.266	0.346	0.422	0.504	0.544	0.686	0.748	0.900	0.992	1.142		
6 (b)	Increment of ...	0	0.084	0.082	0.052	0.080	0.060	0.080	0.070	0.068	0.094	0.102	0.104	0.200	0.234	
	Total ...	0	0.084	0.166	0.248	0.328	0.388	0.468	0.538	0.606	0.700	0.802	0.906	1.106	1.340	
7	Increment of ...	0	0.100	0.060	0.092	0.068	0.112	0.068	0.120							
	Total ...	0	0.100	0.160	0.252	0.320	0.432	0.500	0.620							
8	Increment of ...	0	0.055	0.027	0.033	0.032	0.026	0.056	0.026	0.037	0.052	0.053	0.048	0.057	0.099	0.376
	Total ...	0	0.058	0.085	0.118	0.150	0.176	0.232	0.258	0.295	0.347	0.400	0.448	0.505	0.604	0.980
9	Increment of ...	0	0.055	0.048	0.042	0.042	0.055	0.040	0.060	0.049	0.073	0.072				
	Total ...	0	0.055	0.098	0.140	0.182	0.237	0.286	0.346	0.395	0.468	0.550				
10	Increment of ...	0	0.052	0.048	0.036	0.039	0.055	0.038	0.070	0.064						
	Total ...	0	0.052	0.100	0.136	0.175	0.230	0.268	0.338	0.402						
11	Increment of ...	0	0.072	0.058	0.080	0.035	0.073	0.082	0.050	0.132	0.121	0.207	0.505			
	Total ...	0	0.072	0.120	0.200	0.235	0.308	0.390	0.440	0.572	0.693	0.900	1.405			
12	Increment of ...	0	0.072	0.060	0.063	0.065	0.070	0.063	0.091	0.054	0.112	0.090	0.262			
	Total ...	0	0.072	0.132	0.195	0.260	0.330	0.393	0.484	0.566	0.660	0.770	1.032			
13	Increment of ...	0	0.110	0.090	0.128	0.153	0.293									
	Total ...	0	0.110	0.200	0.328	0.481	0.774									
14	Increment of ...	0	0.043	0.057	0.045	0.053	0.052	0.070	0.050	0.075						
	Total ...	0	0.043	0.100	0.145	0.198	0.250	0.320	0.370	0.445						
15	Increment of ...	0	0.086	0.074	0.088	0.082	0.058	0.072	0.082	0.108	0.150	0.158				
	Total ...	0	0.086	0.160	0.248	0.330	0.388	0.460	0.542	0.650	0.800	0.958				
16	Increment of ...	0	0.050	0.050	0.052	0.028	0.053	0.054	0.055	0.039	0.071	0.050	0.128	0.130	0.180	0.270
	Total ...	0	0.050	0.100	0.152	0.180	0.233	0.287	0.342	0.381	0.452	0.502	0.630	0.760	0.940	1.21
17	Increment of ...	0	0.096	0.052	0.082	0.082	0.065	0.073	0.115	0.071	0.122	0.192	0.234			
	Total ...	0	0.096	0.148	0.230	0.312	0.377	0.450	0.565	0.636	0.758	0.950	1.184			
18	Increment of ...	0	0.105	0.080	0.068	0.079	0.066	0.082	0.080							
	Total ...	0	0.105	0.185	0.253	0.332	0.398	0.450	0.560							
19	Increment of ...	0	0.075	0.050	0.032	0.067	0.040	0.061	0.040	0.063	0.072					
	Total ...	0	0.075	0.125	0.157	0.224	0.264	0.325	0.365	0.428	0.500					
20	Increment of ...	0	0.067	0.033	0.065	0.045	0.055	0.053	0.053	0.049	0.060	0.065	0.080	0.195	0.210	
	Total ...	0	0.067	0.100	0.165	0.210	0.265	0.318	0.371	0.420	0.480	0.545	0.625	0.820	1.030	
21	Increment of ...	0	0.045	0.045	0.060	0.040	0.055	0.035	0.042	0.058	0.035	0.061	0.044	0.070	0.058	0.107
	Total ...	0	0.045	0.090	0.150	0.190	0.245	0.280	0.322	0.380	0.415	0.476	0.520	0.590	0.648	0.755
22	Increment of ...	0	0.042	0.049	0.038	0.039	0.048	0.041	0.053	0.046	0.040	0.054	0.072	0.058	0.090	0.205
	Total ...	0	0.042	0.091	0.129	0.168	0.216	0.257	0.310	0.356	0.396	0.450	0.522	0.580	0.670	0.875

PROPORTION OF BARK TO WOOD IN KIKAR, SAL AND ASSAINA 415

TABLE VI.--CO-EFFICIENT OF ELASTICITY FROM BENDING TESTS.

No.	Name.	Locality.	Range of stress. Pounds per square in.	Elastic deflection per 100 pounds load in inches.	Co-efficient of Elasticity.	
					Pounds per square in.	Tons per square in.
1 (a)	Sapu ...	Ceylon	0 to 7,551	0.0146	1,126,000	502.3
1 (b)	" ...	"	0 to 8,078	0.0145	1,125,000	502.0
2 (a)	Panah Ka ...	"	0 to 12,690	0.0162	1,519,000	678.1
2 (b)	" ...	"	0 to 13,230	0.0171	1,431,000	638.6
3 (a)	Guruktna ...	"	0 to 10,800	0.0160	1,542,000	688.2
3 (b)	" ...	"	0 to 6,673	0.0174	1,403,000	625.9
4 (a)	Vuinaku ...	"	0 to 8,596	0.0254	961,600	429.2
4 (b)	" ...	"	0 to 9,432	0.0262	967,200	431.7
5 (a)	Satinwood ...	"	0 to 12,630	0.0173	1,419,900	633.6
5 (b)	" ...	"	0 to 14,930	0.0144	1,712,000	764.3
6 (a)	Milla ...	"	0 to 14,710	0.0155	1,592,000	710.8
6 (b)	" ...	"	0 to 14,810	0.0152	1,639,000	731.4
7	Hauthai ...	"	0 to 3,000	0.0166	955,900	426.7
8	Mandora ...	"	0 to 6,000	0.0084	1,872,000	835.4
9	Ubbriya ...	"	0 to 4,000	0.0099	1,596,000	712.5
10	Jawenna ...	"	0 to 3,000	0.0089	1,783,000	796.0
11	Dawata ...	"	0 to 3,500	0.0126	1,257,000	561.3
12	Margosa ...	"	0 to 4,000	0.0142	1,109,000	495.0
13	Lucumidella ...	"	0 to 1,500	0.0218	739,000	330.1
14	Walukina ...	"	0 to 2,500	0.0100	1,646,000	734.7
15	Ranai ...	"	0 to 3,500	0.0155	1,028,000	459.0
16	Chomunti ...	"	0 to 5,000	0.0100	1,651,000	737.2
17	Suriya ...	"	0 to 4,000	0.0159	1,014,000	452.6
18	Jak ...	"	0 to 3,000	0.0160	995,600	444.4
19	Del ...	"	0 to 4,500	0.0111	1,418,000	632.8
20	Halmilla ...	"	0 to 5,000	0.0109	1,749,000	780.7
21	Suriya Mara ...	"	0 to 5,500	0.0095	1,736,000	775.0
22	Hedun ...	"	0 to 5,000	0.0090	2,180,000	972.9

Proportion of bark to wood in Kikar, Sal & Assaina.

The following is the result of certain experiments undertaken in the Lahore, Dehra Dun, Kumaun, Garhwal and Ganges Forest Divisions, at the instance of the Inspector-General of Forests, to ascertain the proportion of dry bark to wood in Kikar, Sâl and Assaina trees.

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The Deputy Conservator of Forests, Lahore Division, reports that from experiments made with 5 *kikar* trees, varying in girth from 5 to 6 feet, and of about 25 to 30 years in age, the proportion of bark and twigs to the timber and fuel is as 1 to 4 : i.e., in 100 parts by weight of the whole tree, there are 80 parts of timber and fuel by weight and 20 parts of bark and twigs by weight.

In the above experiments the trees were felled in November 1898 and the weighings were made in March 1899.

The Assistant Conservator of Forests, Dehra Dun Division, gives the details of five well-grown *sâl* trees experimented with in the Dholkot forest as follows :—

	Girth with bark at 4 ft.	Girth, without bark.	Height.	WEIGHT OF				
				LEAVES, GREEN.	TWIGS AND BARK.		WOOD.	
					Green.	Dry.	Green.	Dry.
			Feet-	Seers.	Seers.	Seers.	Seers.	Seers.
A ...	15"	...	35	..	35	14	32	25
B ...	24½"	..	45	15	99½	39½	131½	102
C ...	35"	28½"	71	37½	292	135	595	461
D ...	50"	44"	71	88½	632	322	1,390	1,077
E ..	63"	...	76	100½	772	384	2,357½	1,826

The dry weights have been reckoned out on the assumption that the proportional weights per cubic foot of fresh and seasoned *sâl* are 71 and 55 lbs.

The latter figure is obtained from Gamble's "Manual of Indian Timbers," and the former was obtained from the measurements and weights of one 10" *kari* which were taken on the spot carefully.

It may be noted that D had a bigger crown than the others, having been grown in more open forest. The only general rule that can be deduced is that the proportion of bark to wood, which is high at first, grows less as the trees grow older.

The Conservator of Forests, Central Circle, North-Western Provinces and Oudh, has supplied the figures for *sain* trees given below with the remark that in the Garhwal Division the bark was not quite dry when the experiments were carried out, and it would appear that all the smaller twigs were included

PROPORTION OF BARK TO WOOD IN KIKAR, SAL AND ASSAINA. 417

in and weighed as bark. This probably largely accounts for the difference between the results arrived at by Garhwal and those of the other two Divisions.

Statement showing results of experiments undertaken in the Kumaun, Garhwal and Ganges Divisions with the view of ascertaining the proportion of dry bark to wood in Assaina trees.

Division.	Serial number of trees.	Girth class.	Weight of wood fit for timber and fuel.	Weight of dry bark.	Proportion of dry bark to wood by weight.
			Seers.	Seers.	Per cent.
Kumaun ...	1	I	4,690	705	15.0
	2	I	4,275	890	20.8
	3	I	3,227	528	16.4
	4	II	2,403	370	15.4
	5	II	2,493	333	13.4
	6	II	2,886	480	16.6
	Average		3,329	551	16.5

Division.	Serial number of trees.	Girth Class.	Weight of timber (dry).	Weight of bark (dry).	Proportion of dry bark to timber by weight.	Weight of wood fit for fuel (dry.)	Weight of bark (dry).	Proportion of dry bark to firewood by weight.
		Girth.	Seers.	Seers.	Per cent.	Seers.	Seers.	Per cent.
Ganges ...	1	I—8' 9"	2,083	339	16.3	3,703	697	18.8
	2	I—7' 11"	2,113	223	10.6	3,484	407	11.7
	3	I—6' 9"	1,017	181	17.8	2,225	266	11.9
	4	II—5' 6"	833	111	13.4	1,207	167	13.8
	5	II—5' 7"	912	166	18.2	973	183	18.8
	6	II—4' 7"	466	69	14.8	871	167	19.1
	Average		1,237	181	14.6	2,077	314	15.1

Statement showing results of experiments undertaken in the Kumaun, Garhwal and Ganges Divisions with the view of ascertaining the proportion of dry bark to wood in Assaina trees—continued.

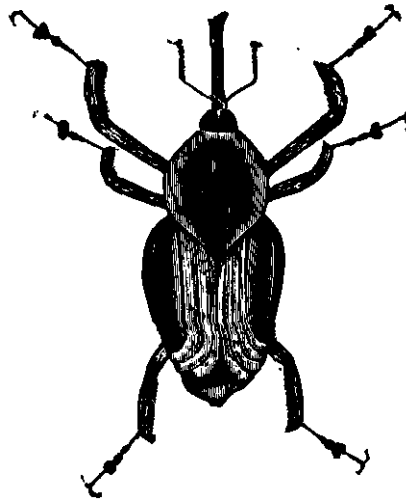
Division.	Serial number of trees.	Girth.	Weight of wood <i>green.</i>	Weight of bark in- cluding unbark- able branches <i>green.</i>	Proportion of bark to wood by weight <i>green.</i>
			Seers.	Seers.	Per cent.
Garhwal	1	8' 0"	6,495	1,355	20.9
	2	3' 4"	958	434	45.3
	3	3' 6"	998	375	37.6
	4	4' 0"	1,097	395	36.0
	5	6' 0"	3,246	619	19.1
	6	6' 4"	2,368	620	26.2
	Average.		2,527	633	25.0

An Injurious Beetle in the Chittagong Division.

I have noticed that in the Sitapahar Teak plantation in the Chittagong Division a weevil, the full life-history of which I have been able to put together, which attacks the young shoots of Paiya or Muli Bamboo (*Melocanna bambusoides*), I sent a specimen to the Indian Museum for identification. The weevil turned out to be *Cyrtotrachelus longipes*, and I was informed that this species had not yet been reported as injurious.

C. longipes is a large, brown-coloured insect, with a dark patch on the thorax and dark patches on the sides of the elytra. The elbow of the antennæ is formed by one long joint coming out a little above the insertion of the proboscis, and by eight small joints, the last being flattened out and enlarged. The accompanying sketch of the insect is natural-size.

The differences between the male and the female should be noticed. The female, as a rule, is larger, the front legs being highly developed. There is also a difference in the two probosces, that of the female being generally more pointed at the apex with the addition of a few sharp protruberances along its two sides on the upper surface, which are generally wanting or only slightly developed in the male.



Imago. Nat. size.

Cyrtotrachelus longipes.

Illustrations are given showing these differences.



Male front leg, (nat. size.)



Female front leg, (nat size.)

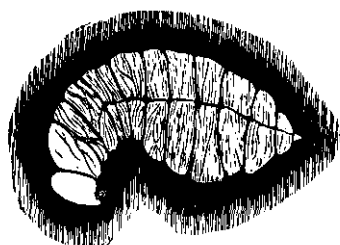
The insects were first found by me on the 26th of June. Four were captured, two being larger than the rest. I got a wooden box, with the top and bottom knocked out, and placed it over some earth in which had been stuck 3 or 4 young bamboo shoots; I covered the top of the box with a bit of perforated zinc, so that the movements of the beetles, which were imprisoned inside, could be seen. After flying about and knocking themselves against the sides of the box, they settled down quietly.

One of the large ones settled on a bamboo shoot. After some time it was found that an oval incision had been made, about $\frac{3}{4}$ in. long and $\frac{1}{4}$ in. deep. On examination I found, at the bottom of the incision, two chips of the soft substance of the bamboo, the size of the eggs I give a drawing of, which were in contact with each other. At first I thought that the beetle was eating. The beetles were taken out in the evening and the young shoot examined. To my surprise I found that the two bamboo chips, of the same whitish colour as the substance of the shoot, were exactly covering two other seemingly similar chips, which on closer inspection turned out to be the eggs which the beetle had laid.



Eggs
(nat size.)

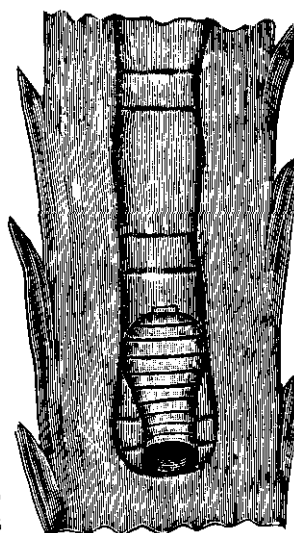
The perfect insects, after emerging, pair soon and the time occupied in pairing and laying their eggs extends to about a month. The beetles may be seen throughout the months of June, July, and the first half of August. The damage to the young shoots was noticed about the beginning of July when the attacked shoots began to die off. The dying shoots were found to contain the larvæ, which are large legless grubs, with slight fleshy tubercles on the under side of the body, corresponding to the number of segments, which are 13, including the head portion. Each shoot was occupied by only one larva, hence it is probable that only one of the two eggs (if they do lay only two) comes to maturity and eventually gives birth to the larva. The shoots attacked were always under about 3 feet in height and consequently thick, fleshy and soft. On cutting some of the attacked shoots it was found that the larva always bored downwards, eating away the soft central portion and increasing in size at a rapid rate.



Larva nearly full-grown,
Natural size.

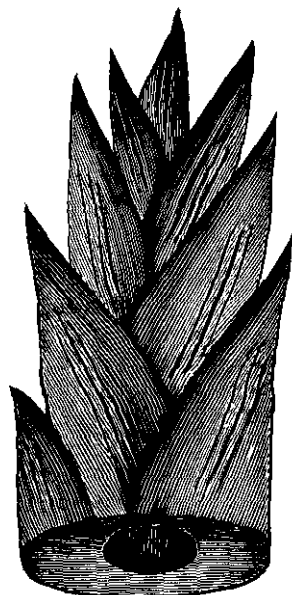
Longitudinal
section.

Young larva
attacking a
bamboo
shoot. Nat.
size.



They make their way downwards (*vide* sketch showing position of grub) till they are fully fed, by which time they probably reach the tougher lower portion of the shoot, they then retreat backwards to their starting point (which is generally about 3 inches below the top), and cut the shoot right off, so that the top portion (3 inches) falls off with the larvæ inside it.

The larvæ were found in all stages of growth on my next visit (15th July). Hence it appears that the larval stage lasts about a month or even less ; and, as it is shown that it takes about a month for the beetles to finish pairing and laying their eggs, we naturally expect that in one month all the larvæ would be fully fed. This gives about 2 months, during which the insect may be found in the larval or injurious stage, *i.e.*, through July, August, and perhaps on to the beginning of September. The young bamboos spring up with the beginning of the rains and by the end of August the ruin is most apparent. Everywhere young shoots are seen dead with their tops off.

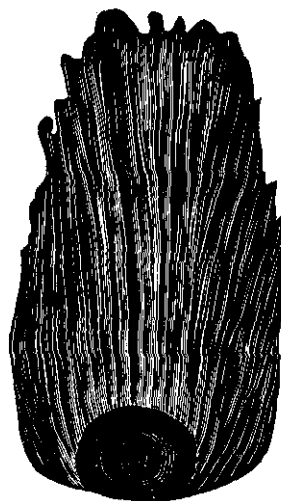


Young bamboo shoot showing the portion which eventually forms the abode of the pupa.

(Nat. size.)

earth, turned out on examination to be the dwelling place of the pupa. It seems that the larva, after being fully fed and letting itself fall with the top portion of the young shoot round it, digs a hole into the soft moist earth and enters it, carrying with it the top of the young shoot, which completely protects it, and there it undergoes its transformation. The top soon decomposes, and only the harder fibres persist. Inside this fibrous covering the pupa remains during the following cold and hot seasons and then emerges as an imago a short time after the first burst of the rains in June, when the ground becomes moist. This moisture seems to be necessary for the effectual casting off of the skins of the pupæ. The pupæ are in close connection with the decayed shoot, which forms a kind of mould, covering every

At this point I was puzzled, as I could find no trace of the pupal stage and much search was made but without success. At last a lump of decayed vegetable matter, almost decomposed to



The dwelling of the pupa.

portion of the pupa. The pupal stage lasts about 7 months, during which time the pupæ with their homes get hardened by the excessive heat, especially towards the commencement of the rains. Then, when it finds that its joints are beginning to get damp, it probably makes its first efforts to escape. The depth below the surface of the ground at which the pupæ are found is about 3 to 4 inches, or even more, depending on the stiffness of the soil. The larva, when full-grown, has a strong pair of mandibles which come in very useful for this digging.

The number of shoots which die annually, owing the attack of these insects, is very large, and it is noticeable that shady places under thick growth are preferred to others. The Kaptai plantation consists of teak, under which there are no bamboos, or only a few ; whereas the forests just outside the parts planted up consist mainly of bamboos, and it is here that the ravages of this insect are centred. As we penetrate further into the forests, their attacks seem to diminish, till at last they cease. They seem to have restricted themselves chiefly to those portions in the vicinity of which there is teak, but the cause of this is not apparent.

The larger legs in the female beetle may be explained by the fact that, the bamboo shoots which she has to grasp when boring to lay her eggs, are generally about three inches in circumference. The front legs of the male would scarcely suffice to grasp so large an object.

Again, the larger size of the proboscis in the female, as compared with that of the male is, no doubt, to enable her to do the extra amount of boring when preparing the egg cavity. and the protuberances which are found on her proboscis may possibly assist in the process of boring into hard tissue.

Kaptai, 18th August, 1899.

J. P. GREGSON.

Colonial Timbers for British Carriage Builders.

A deputation from the Institute of British Carriage Manufacturers visited the Imperial Institute some time ago, for the purpose of inspecting the various timbers in the Colonial and Indian Collections and ascertaining their suitability for use in carriage-building. It was pointed out that, in the manufacture

of carriages for different climates, the selection of suitable timber had become a question of great importance to the trade, as it was found that the woods which were well suited to a temperate climate were quite unsuitable for use in the tropics, and *vice versa*. The deputation closely examined many of the samples of wood displayed and were very favourably impressed with the extensive collection, of the existence of which, prior to their visit, the greater number of its members were quite unaware. There is no doubt that individual members of the carriage-building trade would find it advantageous to visit the Imperial Institute and examine for themselves the specimens of timbers exhibited in its galleries.

One of the chief wants of carriage-builders at the present time is wheel timber of fine quality, grown and very carefully seasoned in a tropical climate, to enable wheels to be made that will wear well on carriages sent to tropical countries. The following woods are mostly used in this country for the parts of wheels:—for the stocks, elm; for the spokes, oak; for the felloes, ash. For stocks the wood must be dense and tough, and capable of holding the wedges of the iron axle boxes without splitting. The spokes must be hard, tough and elastic. The felloes must be hard and tough, and the grain of the wood should follow the curve of the wheel. Planks for the foot-boards, bottoms and panels of carriages must be free from knots, and season without cracks absolutely, must resist the influence of damp and of water, must be fairly dense, tough, and be easily bent when steamed. They should also not exude any sap or other substance which would prevent paint adhering or injure the paint or varnish subsequently.

The Colonial woods that found most favour with the deputation, as best suited for use in carriage-building, were:—New South Wales: White beech, red ironbark, spotted gum, grey ironbark. Victoria: Blue gum (for spokes), blackwood, box (for stocks) ironbark (for spokes). Queensland: Red cedar (for panels). India: Teak, sissoo (*Dalbergia sissoo*), Canada: Black ash, slippery elm, common elm, red and black oak, black and white birch, shell-bark hickory, black walnut.

Another important requirement of carriage-builders is a suitable timber to supplement the failing supply of English ash, its characteristics of strength without excessive weight, freedom from internal strain in seasoning, and its toughness and elasticity, being a combination of qualities very difficult to find in any other wood. With the view of bringing this matter to notice in our colonies, letters were written to the proper authorities in Canada, the West Indies and Australia, forwarding a small sample of English ash, with a description of the qualities most important in carriage-building, and requesting that if any similar timber could be found likely to become a suitable substitute, samples should be sent to the Imperial Institute for practical trials, together with information as to price, dimensions, and extent of possible supply.

The samples which were forwarded in accordance with this request were duly submitted to tests, by the Institute of British Carriage Manufacturers, copies of the reports being furnished to the senders of the samples. With regard to the samples received from Canada :—European ash is not indigenous to Canada, and is only planted as an ornamental tree. The white ash of Canada is most nearly similar to English ash, but the tree was believed to be too scarce for any extensive export to be made. It was thought probable, however, that small lots could be collected from the numerous local mills and thus, if a regular market could be established, a considerable quantity might be rendered available for export. A favourable report was received from the Institute of British Carriage Manufacturers on the logs of white ash, to the effect that the wood was considered “a very good supplementary to English ash, and a favourable opinion was formed as to its working qualities.” In the province of Nova Scotia white ash is more abundant, but the trees are very small in size. The sample logs, although the wood possessed some of the toughness and elasticity of English ash, yielded planks of too small an average width (eight inches) for any extensive application in carriage-building. If rather wider timber could be supplied, it would be very useful for bent work, as Victoria heads, van rails, etc., and for door pillars and such work. A small sample sent from Jamaica was also reported on favourably, although the sample was too small for a definite opinion to be expressed. Large sample planks of this wood, Santa Maria wood (*Calophyllum calaba*) have since been received, but after further trials it was not thought suitable or the best class of work.

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[11.

On the determination of the Fungi which attack Forest trees in India.

The study of the fungi which are found in the forests of India, either as parasites on the leaves or as causing decay of the wood, or again as saprophytic plants on the ground in the forests, is one which so far has made but little progress. Most forest officers, however, know how exceedingly important the subject is, and many of them have had opportunities of seeing what has been done in Europe to work it up, and most especially in Germany. The real pioneer in the study of forest-tree pathology was undoubtedly Prof. Robert Hartig of Munich, whose text book of the "Diseases of Trees," which is available to English students in the excellent translation of Dr. W. Somerville, revised and edited by Prof.^o Marshall Ward, F. R. S. (Macmillan & Co. 1894) is one of the most interesting works which a forest officer who observes the processes which are going on in the forests, inimical to forest tree-growth and development, can study. There is an excellent, if somewhat brief, account of the principal European tree fungoid diseases, by Mr W. R. Fisher, in the 4th Volume of Dr. Schlich's Manual of Forestry, and another in Prof. Marshall Ward's 'Timber and some of its diseases' (Macmillan & Co. 1869). But the most important and most astonishing book on the subject is the monumental work of Dr. Karl Freiherr von Tubeuf which has been translated into English by Dr. W. G. Smith of Edinburgh as 'Diseases of Plants, induced by Cryptogamic Parasites' (Longmans, Green & Co. 1897) a work which is practically a dictionary of all that is known on the subject and refers, not merely to European plants, but to the plants of the world and those of their fungoid diseases which have been so far discovered. A mere cursory examination of Dr. von Tubeuf's great work is sufficient to open the eyes of even the most conservative and sceptical of Foresters to the importance of the subject and to the amount of information which still remains to be obtained regarding it. It is clear that there is hardly a plant among the higher order that is not

affected by some, indeed often by many, parasitic and epiphytic fungi; and the wonder is that with so many foes, plants cultivated and wild and forest trees are able to maintain successfully their powers of growth and reproduction. So far as they were known at the time he wrote, Dr. von Tubeuf made mention of the Indian species.

It is fortunate that, so far as observations have yet gone, the chief forest trees of the hotter parts of India have not been found to be affected by injurious fungi to the same extent as are the forest trees of Europe and their allies of the Himalaya, but in the Himalaya the fungi are often very much in evidence and even in the plains there are some of considerable importance, a few examples of which may be given.

In January 1891, I visited the Changa Manga Plantation with the Forest School students who were on tour there under the supervision of the Deputy Director, Mr. Fernandez. Not far from the Forest and Canal Bungalows, in a low-lying rather damp area, many dead and dying trees were met with. On being cut into, the stems of these trees were found to be permeated in every direction by the white mycelium of a fungus. At first, we thought that possibly the fungus might be one of those species which attack only dead wood, but the presence of the mycelium in still living trees was against this, and after a considerable search, the sporophores of a large species were found, with every indication that they belonged to the mycelium in the wood. The sporophores consisted of a large, dark, red-brown, bracket, fixed to the tree at one side close to the root; the upper surface measured perhaps a foot to a foot-and-a-half in length and 6 inches or more in breadth, and showed several rings indicating its gradual growth. The spores were in tubes on the under surface in the manner characteristic of the *Polyporeæ*, and the fungus, on being sent to Kew for identification, proved to be a new species and was described by Mr. G. Massee as *Polystictus egregius*. By some authors *Polystictus* is regarded as a section of *Polyporus*, that large genus of Hymenomycetous fungi which possesses so many members destructive to forest trees and timber in Europe, among which perhaps the most noticeable is *P. sulphureus*, which has sporophores very closely resembling those of the Changa Manga plant. Again, when on tour in 1889 in the Casuarina plantations of Nellore in the Madras Presidency, a similar case of dying and dead trees was observed, and the only specimen (a very young and imperfect one) which was obtained of the sporophore, was found to be very similar to the Changa Manga one and may very likely have belonged to the same species. In both cases, I remember to have very strongly urged the local officers to follow up the subject, and specially to study means for getting rid of the pest, but I have never since heard if anything more was done, and fear that *Polystictus egregius* is

still at work trying to ruin the beautiful plantations of Sissoo in the Punjab, and the Casuarina groves of the Madras coast. Of other *Polypori* the most noticeable perhaps is *Polyporus (Fomes) fomentarius*, which is everywhere conspicuous in the North-west Himalaya especially on the 'bán' oak (*Quercus incana*) and the birch (*Betula alnoides*), the sporophores consisting of a huge, hard, grey, reversed bracket. This fungus, which thrives both on living and on dead trees, perhaps more frequently on the latter, is also common in Europe, where, up to quite recently, and indeed still to some extent, the dried sporophores are used for tinder. Many of us can still remember the 'amadou' matches which used to be sold in the cities of Europe for lighting cigars, and which were made of the dried felt of the sporophores of this species.

For many years, the parties who have visited the deodar forests of Jaunsar yearly for the instruction of the students of the Forest School, have been interested and puzzled by the groups of young dead deodar to be met with here and there, the cause of death being not at once apparent. Often have we dug up specimens, only to find what might have been expected, that the roots and the lower parts of the stems were fully permeated by the mycelium of some fungus, *but what kind of plant it was and what could be done to stop it we had no means of telling*. Last autumn, however (1898), spring searchings having invariably failed, I was in Jaunsar and took every opportunity of hunting for the sporophores and at last was successful in finding a rather poor specimen which was unmistakeably the cause of the death of a fine young deodar near the Jako pass. It was sent to Kew and proved to be *Polyporus (Fomes) annosus*, Fries, better known by the older name of *Trametes radiciperda*, Hartig, and described by Hartig as "undoubtedly the most dangerous of all the parasites met with in coniferous woods, not only because it produces the worst kind of red-rot, but also on account of its being the most common cause of gaps in both young and old plantations." It is impossible to exaggerate the importance of this sad discovery. The Forest Department is very properly yearly spending on the reproduction of deodar large sums of money and so far the success has on the whole been considerable, better perhaps with natural than with artificial reproduction, but still good in both cases. In Jaunsar and in the neighbouring leased forests of Tehri-Garhwal, the disease is, so far as my own observation goes, on the increase, and it is now time to take strong measures to stop it before it goes too far. It is propagated, as is well known and as is described by all the writers on the subject, Hartig, Marshall Ward, Fisher, von Tubeuf, chiefly by the contact, in the soil, of the roots of adjoining trees and the remedy proposed, and for long adopted in Germany, is to isolate affected trees or patches of trees by digging trenches around them sufficiently deep to prevent their roots

passing beyond and communicating the disease to neighbouring trees. Further details must of course, be worked out on the spot, but I strongly advise early action or the spread of the enemy may be too quick and we may lose some of our finest and most promising areas of reproduction.

These few examples ought to show sufficiently clearly how very important the subject is, and if we are to utilize to the full the information obtained in, and the experience of, Europe, we must begin by searching for and finding the sporophores and obtaining their identification. The identity of the fungus which attacks the stems of the Kharshu (*Quercus semecarpifolia*) trees at Deoban in Jaunsar, requires to be investigated. From the fact that it is apparent both in the mycelial form of white threads disintegrating the wood, and in the form of long black stout rhizomorphs it is most probably the well-known *Agaricus melleus* or an allied species, but the discovery of the sporophores is necessary in order to settle the question.

In the case of Hymenomycetous fungi like those already mentioned, it is not always easy to find the sporophore and identify the enemy; but in other cases, and especially in the case of the leaf-diseases, it is not so difficult. Most of those who have worked in the sub-Himalayan sâl forests have noticed that in some years the leaves of the trees, often over considerable areas, appear as if covered with soot. A very little examination of the effected leaves shows that the black appearance is due to a fungus, but although the spores of the fungus were readily found, its nature remained for some time in doubt. Specimens collected by myself in Dehra Dun and by Pandit Keshavanand in the forests of Oudh were sent to Dr. D. D. Cunningham, F. A. S., of Calcutta, and his report was that the blight was a "Meliolaceous" Pyrenomycete.... not parasitic but merely epiphytic and that "where they do any injury to the host, it is purely due to their interfering with assimilation and respiration from the dense surface-coating which they ultimately tend to form." A note on the subject appeared in the "Indian Forester" Vol. XX, p. 156 and further specimens were sent to Kew where they were identified as *Meliola amphitricha*, Fries. Thus two investigations were satisfactory and showed that after all, unless the fungus was very bad indeed, it was not to be expected that it would cause greater injury to the sâl forests than a slight retardation of growth. So is it also, generally, with the well-known conspicuous orange-coloured uredineous fungi which occur on the leaves of Himalayan conifers and which were the chief subject of the paper in the "Indian Forester," Vol. XXI, p. 126, by Mr. J. Nisbet, with pictures from photographs taken by Mr. C. G. Rogers. The chief of these was the yellow tassel-like fungus on the young leaves of *Picea Morinda* called by Mr. Nisbet *Acidium Thompsoni* and iden-

tified at Kew as *Peridermium incarcerans*, Cke. and by Barclay as *P. piceæ* Barcl. This bright-looking fungus is, as Mr. Nisbet pointed out, closely allied to the *P. coruscans*, Fries, which attacks the spruce tree of Europe and is occasionally eaten by the peasants in the north, and I believe it is itself occasionally used as an article of food in the Himalaya. The damage done by it is not very great unless it happens to attack the principal leading shoot of the tree. Then there were also the Peridermia of the pines, *Pinus longifolia*, and *P. excelsa*, identified at Kew as *Peridermium orientale*, Cke. These appear as small orange-coloured sacs of spores on the needles of the trees here and there, but do little harm unless they occur, as Mr. Nisbet points out, on the branches in the form of the var. *corticola*. They have been described, in more detail, in Mr. Nisbet's paper already referred to, as well as in Dr Cooke's paper in the "Indian Forester," Vol. III, p. 88. The *Peridermium pini* of Europe, which is found on the Scots pine, is known to be in its leaf-attacking variety the æcidial form of *Coleosporium senecionis*, a fungus which attacks the groundsel, but the corresponding alternate plant of the *P. orientale* has not yet been discovered and here there is some scope for the investigator. As regards the alternate form of the var. *corticola*, Hartig says:— 'It is to be regretted that so far the plants have not been determined on which the teleutospores are produced. Until we discover the teleuto form, preventive measures must be confined to felling pines that are attacked.' Dr. Barclay thought that the forms on *Pinus longifolia* and *Pinus excelsa* were distinct, and named them, respectively, *Æcidium complanatum*, Barcl. and *Æ. brevius*, Barcl. (see Jour. As. Soc. Beng. lix. ii. 101-102). He thought at one time, that the latter might possibly be the æcidial form of *Chrysomyxa himalayensis*, a bright orange-coloured fungus very common on the petioles of the leaves of Rhododendron trees in the hill forests, but afterwards changed his mind and considered that the alternate host of the latter would more probably be *Picea Morinda* and the fungus *Æcidium piceæ* (see Scientific Memoir of Medical Officers of the Army of India, Part VI, 1891, p. 71.)

An interesting example of alternate generations in fungi is given by Dr. Barclay in the same Scientific Memoir, Part V 1890, p. 71, where he shows that the *Gymnosporangium Cunninghamianum* which grows on *Cypressus torulosa*, Don, has its æcidial form on the wild pear *Pyrus Pashia*. The cypress fungus is that one which may be seen in abundance about Bodyar in Jaunsar, having, in wet weather, the form of gelatinous yellow masses. Nisbet in the 'Indian Forester,' XXI, 132, speaks of these as a *Nostoc* or *alga* but this is not mentioned by Barclay.

Another example, perhaps the best known example, is that of the 'rusts' of wheat and other cereal crops and

grasses. A very full account of these rusts was published in 1897 by Dr. Prain of the Royal Botanic Gardens, Calcutta, in 'Agricultural Ledger' No. 16 in which he explains how, among others, the 'Black rust' (*Puccinia graminis*) which attacks wheat, oats, barley and rye, as well as other grasses, has its æcidial stage on species of barberry (*Berberis*); the 'Brown rust' (*P. dispersa*) which attacks wheat and rye and other grasses has its æcidial stage in various species of the 'Borage' family; and the 'Crown rust' (*P. coronata*) which attacks chiefly oats and other grasses has its æcidial stage on various Buckthorns (*Rhamnus Berchemia*, etc). Dr Prain explains how it is not yet known exactly whether the common rusts of India have their æcidial stages on other plants, and if so, what plants these are, but we do know that æcidia of a fungus which has at Kew been identified as *Puccinia graminis* has been found on *Berberis aristata*, that *Puccinia coronata* has been identified as attacking *Rhamnus purpureus* and *virgatus* and that a fungus described by Mr. Barclay as *Uredo ehretiae* has been found in the Himalaya attacking the Boraginous tree *Ehretia serrata*, and may be possibly identical with *Puccinia dispersa*; so that there is every reason to think that, at any rate, in the neighbourhood of the north-west Himalaya the principal rusts of the cereal crops are traceable to the leaf-fungi of Himalayan forest trees and shrubs.

The pages of the 'Indian Forester' contain several articles of interest on the subject of Indian parasitic fungi, and more especially can we draw attention to Dr. M. C. Cooke's admirable papers in Vol. II. p. 380; and Vol. III. p. 14. Dr. Cooke was also good enough to name for me some specimens collected by myself and others, and these are mentioned in Vol. IV. page 90 and page 197.

The chief workers in the field of the Indian fungoid diseases of plants have been Dr. D. D. Cunningham, F. R. S., who has lately retired from service in broken health after many years of hard work in Calcutta; and Dr. A. Barclay who died in 1891 at Simla of typhoid fever at the early age of 39, to the great regret of his many friends and correspondents, and to the great loss of Indian scientific work. A notice about him and his work will be found in the "Indian Forester," Vol. XVII. page 303.

It may be well here to mention a few of the species which attack forest trees, which were described by Dr. Barclay, chiefly in the Journal of the Bengal Asiatic Society.

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| 1 on <i>Berberis aristata</i> | the rust <i>Puccinia graminis</i> , Pers. |
| 2 on <i>Hypericum cernuum</i> | the yellow <i>Melampsora Sanctis Johannis</i> , Barcl. |
| 3 on <i>Rhamnus dahuricus</i> | the rust <i>Puccinia coronata</i> , Corda. |
| 4 on <i>Vitis himalayana</i> | <i>Uredo cronartiiiformis</i> , Barcl. |
| 5 on <i>Acacia eburnea</i> | <i>Æcidium esculentum</i> , Barclay. |

The attacked twigs are eaten in the Poona District, as reported by Mr. R. C. Wroughton—see Pro. Bomb. Nat. Hist. Sec., Vol. 2.

- 6 on *Rosa marcerophylla* *Puccinia Rosae*, Barcl.
 7 on *Rosa moschata* *Phragmidium subortitium*, Schrad.
 8 on *Rubus lasiocarpus* *Phragmidium Rubi*, Pers.
 9 on „ *biflorus* „ *quingueloculare*, Barcl.
 10 on „ *paniculatus* „ *incompletum*, Barcl.
 11 on *Pyrus variolosa* *Gymnosporangium clavariiforme*, Jacq.
 the alternate form of this probably comes on Juniper.
 12 on *Pyrus Pashia* *Gymnosporangium Cunninghamianum*, Barcl.
 alternate form on cypress, see above.
 13 on *Cotoneaster bacillaris* *Gymnosporangium Cunninghamianum*.
 14 on *Astilbe rivularis* *Xenodochus Clarkianus*, Barcl.
 very common—spores bright yellow on the leaves.
 15 on *Deutzia corymbosa* *Uredo Deutziae*, Barcl.
 16 on *Rhododendron arboreum* *Chrysomyxa himalayensis*, Barcl.
 17 on „ *lepidotum* *Uredo* sp.
 18 on „ *campanulatum* *Æcidium* sp.

It is supposed that these latter may all be connected in some way, but the question still requires solution. But it seems more probable that the first has its alternate stage on *Picea Morinda*.

- 19 on *Jasminum humile* *Æcidium Jasmini*, Barcl.
 20 on „ *grandiflorum* *Uromyces Cunninghamianus*, Barcl.
 21 on *Ichnocarpus frutescens* *Uredo ichnocarpi*, Barcl.
 22 on *Ehretia serrata* *Uredo ehretiae*, Barcl.
 On this see also "Indian Forester" XVIII. 21 and above.
 23 on *Colebrookia oppositifolia* *Uredo Colebrookiae*, Barcl.
 24 on *Ficus palmata* *Æcidium Mori*, Barcl.
 25 on *Morus serrata* *Cocoma Mori*, Barcl.
 26 on *Populus ciliata* *Melampsora ciliata*, Barcl.

This is a light yellow fungus found on the leaves, the white one which makes the leaves look as if powdered with lime being *Uncinula salicis*.

- 27 on *Populus alba* *Melampsora æcidioidea*, Barcl.
 28 on *Pinus longifolia* *Æcidium complanatum*, Barcl.
 29 on *Pinus excolsa* *Æcidium brevius*, Barcl.

Both these species are now united as *Æcidium orientale* as already described.

- 30 on *Picea Morinda* *Æcidium Thompsoni*, Barcl.
 31 on do. *Æcidium piceae*, Barcl.

on these, see previous remarks.

- 32 on *Cedrus Deodara* *Æcidium Cedri*, Barcl.

This forms small yellow spots, and the leaves turn yellow, bend down and fall off, but the damage done is not great.

Since Dr. Barclay's work, little or no original work has been done in India on the fungi which attack forest trees, but many specimens have been collected and sent to Kew for naming and the first instalment of these was published in the Kew Bulletin for June 1898. The chief of these which are parasitic on forest trees are:—(1) *Gambleola cornuta*, Massee, which occurs as black tufts on the leaves of *Berberis nepalensis* and is very common about Chakrata, and (2) *Melampsora epitea* Thüm., which is found as yellow masses on the under surface of leaves of *Salix elegans*. Others have also been named and will doubtless appear described in future numbers of the Bulletin; among

them may be mentioned: *Exobasidium cinnamomi* Massee, the remarkable growth on the branchlets of *Cinnamomum Tamala* referred to in Mr. Nisbet's paper ("Indian Forester," Vol. XXI. p. 133) as *Exoascus* and producing a large bushy kind of witches' broom, seriously deforming the branches of the trees. It was found near Thadyar in the Tons valley; (2) *Stereum lobatum*, Kunze, a large hard fungus found on oaks (*Quercus dilatata*) in Jaunsar; (3) *Rosellinia spadicea*, Cesati, a black fungus found on the lower part of the old culms of *Arundinaria spathiflora*; and (4) *Trichosporium aterrimum*, Massee, a curious black species which apparently does considerable damage to mulberry trees in Changa Manga. It was discovered by Mr. F. Gleadow.

Besides the parasitic species, there are many interesting fungi attacking dead wood. One of the most noticeable of these is the scarlet *Polystictus sanguineus* Fries, so common in the sâl forests; the prettily-shaded *Polystictus versicolor*, Fries, is also abundant in sâl forests on dead bark; *Hymenochaete Mongeotii*, Cooke, is a dark red fungus, occurring in large patches on the outer bark of *Betula alnoides* in the Himalaya. *Lentinus*, *omphalomorphus*, Mont. and *Dædalea Schomburgkii*, Berk. are white fungi conspicuous on sâl logs. *Hydnum Gleadovii*, Massee, is a beautiful sponge-like fungus of similar situations.

It has only been possible to mention a few of the many kinds which have been discovered of recent years. Specimens of most of them are deposited in the Museum and Herbarium at Dehra Dun, but there is much more yet to be done, and the chief object of this paper is to urge Forest Officers to collect specimens and send them for identification through the Director of the Forest School, where duplicates should always be kept, allowing the originals to be retained at Kew. I feel sure that the Director of Kew will be very glad to assist in obtaining names, and that Mr. G. Massee will be delighted to continue to publish such new species as he may find among the collections sent. The information obtained cannot fail to have an important bearing on forest management especially on that of the forests of conifers of the N.-W. Himalaya, and by degrees materials can thus be collected towards a Handbook such as it is obviously desirable that we should possess. Leaf fungi can be collected and dried like ordinary Herbarium specimens, larger species can be merely dried loose and packed in paper. It is of the utmost importance to give full information and notes, and above all, to give the name of the plant upon which the fungus is found.

J. S. GAMBLE.

Another Exploit of my Bull Terrier.

The Editor of the "Forester" was so kind as to think my story of one of the adventures of my bull terrier and self worthy of publication, that I am tempted to send another, the more so as this story is more to her credit than the one relating to her turn up with the wild tusker.

One hot weather my assistant P. and self were out inspecting fire-lines and trying to ascertain how much of the Reserve had been burnt over by a particularly disastrous fire that had run through some time previously. On arrival at a small village near the Reserve two old friends of mine turned up beaming, in fact, their costume would have almost justified the reporter's phrase that they "were clothed with smiles" as they had jolly little else on. The men, Maung Shwe and Maung Kyaw, had been my companions in many a weary tramp, sometimes crowned with success and sometimes not, after bison, hsaing and all the deer. They thought I had come for no other purpose except shikar, and visions of heaps of dried meat floated before them. Had not two Forest Officers come to camp at their village, one of whom was a very old friend?

They partook of lemonade before an admiring and envious crowd returning thanks in a way not usual in polite society, but which was a very good advertisement of the gasiness of the fluid. Then having each lit a big white fat cheroot, they proceeded to inform me that hsaing were plentiful on the old kwins, and "thakin a herd of bison, over thirty at least, come out of the Fairies wood every day, morning and evening, to eat the tender grass shoots in the Indaing, and the old big bison male, the solitary one, he also sleeps daily in the Fairies wood. It is evident he wishes to die, coming here at the same time as my lord," and Maung Shwe looked round approvingly as there

was a low chorus of "hòkth" (It is true) from the squatting throng. P, whose first year out had not come to an end, was anxious for a try at something, so I lent him my 500 Express and taking my 12 bore Paradox next morning we started off betimes, P going off to the hsaing ground and self to look for tracks round the Fairies wood (Nat taw) a thick patch of evergreen unburnable jungle just outside the reserve and about 3 miles from the village. Tracks all round were very plentiful, in fact too much so, and it was next to impossible to distinguish the fresher ones from those a few days old. We wandered about being continually baffled till the April sun got too much for me, so going off to a nullah we camped under a bank near a foetid pool into which the bull terrier wallowed and lay gasping. The weary hours passed somehow, the two Burmans slept, I was going to say peacefully, but emitting a noise like a pair of well-fed bull frogs hardly fits the term; the afternoon at last began to wane, the joker who wrote the story about the land of Cockayne, where it was always afternoon, had evidently not been in Burma in the hot weather, if so, he would not have written such rubbish or anyway his bill of fare wouldn't have included roast *moorgi*. I stirred the Burmans up, and about 5 o'clock we made our way cautiously back towards the Fairies wood; we were creeping along the edge and just going up the steep bank of a nullah when Maung Shwe, who was leading, dropped back as if shot. I grabbed the terrier and taking off my topee, peered over a small kwin (area devoid of trees); there, grazing on the new shoots of elephant grass, were 13 bison; the new grass was about 3 feet high so the stalk (as there was no wind) to a "Butea frondosa" tree about 30 yards from the lot wouldn't be difficult. I whispered to the men to hang on to the dog till they heard a shot and then let her go. I then started crawling on my hands and knees towards the tree, the thick burnt stems of the grass gave my hands and knee caps beans so I was thankful to reach my point; getting into an erect position I looked round, the beasts had grazed away from me except one, to the left near the wood, which was only about 60 yards away and head on.

I took a careful plug at the shoulder, and the change! Every animal threw up its head and started rushing for the shelter of the jungle streaming across my front. I tore across an open strip diagonally to cut them off and got a beautiful shot in at one and then dashed after them. About 6 yards inside the jungle I came on the animal shot last, stone dead, but a tell-tale trail of blood led on into some thick *tabin* bamboo showing that the animal first hit had gone on. I thoughtlessly ran on in the broad track left by the flying herd, till I was brought up by hearing a deep snort; looking up I discerned in the gloom the head of a bison thrown well up and staring wild eyed at me. I saw I was in for a charge and next second it came off, down

hill dashed the infuriated creature, I reserved the shots till the last moment, then letting off both barrels I sprang aside, my foot caught in a creeper and as I fell headlong my gun flew out of my hands. I felt my coat torn open and found myself lying down with the bison's chest on my out-stretched thigh. Now, Mr. Editor I have a fair chance for some tall writing about visions of all my past life floating before me; alas none came and my imagination is poor; all I remember thinking of was what a large eye the beast had got. Next second I saw a flash of white and my bull terrier had leapt across my body and closed with the bison, fixing her teeth firm in the beast's great india-rubber-like nose; the bison struggled to its feet and so you bet did I, my only idea being to get away. I felt very shaken and blundered away through the jungle till I suddenly felt myself falling and came down full length in a deep narrow nullah; I went down this for about 50 yards and coming to a pool, foetid and stinking, yet containing liquid which was I suppose 50 % water, anyway I lay down and drank, then feeling very revived I got out of the nullah and made my way back to my men. I was covered with blood and their concern on seeing my plight, hatless, gunless, covered with blood, dust, and a black grease off the bison, was great; however, on finding the blood wasn't mine they were relieved and we sat down to a council, as the dog shortly turned up wagging her tail, very blown but none the worse. I was for leaving the beast till the morning and coming with a spare rifle and then finishing the brute off. Not so the other two. With the Burman's insatiable desire for meat they wished to make sure and so it was decided that we should all go in and try and recover the Paradox and then have another shy that night, so in we went cautiously and I had luckily marked a tree with a Butea creeper nicely coiled round it, which I could go up; we had only just got into the jungle when we heard the charge coming. I went up my tree like a greased flash of lightning and the two Burmans each walked up a sapling; however, the bison had spotted one of the men and furiously charged his tree, it was only about 2 feet in girth with one fork near the top. I expected Maung Kyaw to be shot out like a stone from a sling but he hung on like a tick and worming himself into the fork, took off his paso and tied himself on. Then he commenced to abuse the bison, calling it the child of a female dog and making many disparaging remarks about its female relatives and the only treatment they were fit for; this seemed to annoy the bison for, every time Maung Kyaw started off on a compliment, the bison charged the tree. I tried to head the bison off with the dog but though the dog baited the brute finely it was no use, the animal meant to stick to the man up the tree; so entreating Maung Kyaw to give his inventive faculties and language full play I whistled the terrier off and then Maung Shwe and self

carefully crawled down our respective trees and got out in the open. Camp was 3 miles away, it was rapidly getting dark, so I called out that we would go back and return with rifles, etc. Maung Kyaw, however, entreated me not to desert him as he was frightened of ghosts, so telling Maung Shwe to hurry to camp and explain matters to P. I promised to stay. I got as near Maung Kyaw as I could, got up a nice tree with the dog in my arms and sat down to wait. Every one of your readers has heard on a still night at home, when lying awake, the chairs creak as if some ghostly visitor was sitting down on them, well in that seemingly interminable wait I heard similar noises in the jungle. At first I thought it was a leopard on the dry leaves and called to Maung Kyaw but he said it was only "the jungle frightened," there was not a breath of wind so it must have been the rapid cooling of the air which caused these weird sounds. The bison kept a quiet and determined guard at the foot of Maung Kyaw's tree only moving to charge the tree if Maung Kyaw spoke. At last I heard the *touk, touk*, of the wooden elephant bell and my halloo was answered by a faint one in the distance; soon P. turned up with 5 elephants, spare rifles, whisky, soda, food, and blankets (it was about 9 o'clock), very much concerned as he understood I had been damaged; however the way I put down a whisky peg assured him there was nothing much the matter. Well, we couldn't do anything that night, it was pitch dark and the jungle too thick, whereas if the bison charged the elephants would have stampeded so, lighting a big fire we left a guard with rifles and went to camp to bed. I thus lost giving the beast the *coup de grace*, as, when we arrived on the spot next morning Maung Kyaw was down from his perch and the bison dead; one of the mahouts had crawled along the nullah and fired from a range of about 20 yards, missing clean, and near breaking his shoulder blade with the recoil; another sportsman then took the rifle and hit the beast on what the Burmans call the "pin," that is, what the beast would sit down on if it was two-legged, the second shot, he told me with great glee, hit the "baik" *anglice* belly, the bison now seemed to have had enough and started limping up the hill. Maung Kyaw hurriedly came down his tree, took the rifle, and pursuing the brute shot it dead.

I found I had hit with all three of my shots, the first had lodged between the coracoid and the humerus, splintering the former and chipping the latter, the other two had hit far back, one on each side of the back bone, how I managed to get home there, is beyond me. And here ends my yarn (I fear rather a lengthy one) of the most determined animal I have ever fired at, and out of which only my bull terrier and the bison came with credit; after all, the horns were not worth keeping but Maung Kyaw and his pals got a blow out of meat, so it's an ill wind, etc.

TAWKWE.

A New Textile Plant.

Some years ago, an explorer in Asia discovered a plant of silken fibre, used by the Turkomans for the manufacture of withes and cord, and by the Canagues, for woven goods. This plant, known as *Apocynum venetum*, is a sort of bush with slender cylindrical branches, sometimes 6 feet high. It grows in Europe, Siberia, Asia Minor, the north of India, Manchuria and Japan but is not cultivated, and, up to the present has been used only in the natural state. The branches die yearly, and in the spring new shoots start horizontally from the roots. It flourishes best where the land is under water during a part of the year, notably in the neighbourhood of rivers that overflow at stated periods. Under favourable conditions the *Apocynum* develops quickly, and in a short time the branches form a thick growth, almost like a miniature wood. The best fibre is obtained by cutting the branches in midsummer, when the plant has obtained its full growth. The attention of the Russian Government was called to this plant in 1891. It is there known as the *Apocynum sibericum*, because it was first seen in Siberia. It grows luxuriantly on the banks of the Amu-Darya, and the Ili, and the natives of the regions have used the fibre for many years for cord and fish nets. They value it not only for its great strength, but also because no care is required in its cultivation. In 1895 the Russian Government began to use it in the manufacture of bank notes, and since then the plant has been cultivated at Poltava. The results obtained thus far are considered excellent, and the time is doubtless near when the *Apocynum venetum* will take an important place in the textile market.—*Commercial Intelligence*.

The direct assimilation of Carbohydrates by plants.

Up to within very recent times a firm line of demarcation in the vegetable kingdom has been drawn between the higher or green plants which contain chlorophyll, and the lower or non-chlorophyll-containing plants. By means of their chlorophyll apparatus, the higher plants absorb from the sun's rays energy which enables them to decompose water and the carbon dioxide of the atmosphere into their elements, from which a fairly simple chemical substance is first constructed; and then, by a progressive series of reactions, the highly elaborate and complex materials, such as starch, gums, oils, tannins, and various sugars, which are easily identified as plant-constituents. The first product is usually held to be formic aldehyde, though it has not yet been identified in the plant itself as such. Many of the complex substances, however, have been artificially prepared from formic-aldehyde by the skill of the chemist in his laboratory, so that the indirect evidence is fairly conclusive, and the theory will probably be held good until actually disproved. The lower plants, however, being without chlorophyll, are obliged to make use of complex substances already elaborated. The fungi, for example, possess a destructive energy which enables them to break down for their own use, such substances as sugar, bread, wood, leather, and other organic materials upon which they are commonly found growing. These are thoroughly established views. Thus, in a recent *resumé* of the subject of plant assimilation, entitled, "The origin and formation of organic matter in plants,"¹ which was republished in the *Journal* of the Royal Agricultural Society as late as June last,² a careful and detailed account of this mode of carbon assimilation is set forth. Moreover, it is the only method which the writer considers it necessary to refer to, although he deals very fully with the latest work that has been done on the allied subject of the fixation and assimilation of atmospheric nitrogen by certain families of green plants.

Evidence is now gradually accumulating, however, that this is by no means the whole truth on the subject of carbon assimilation. Since the year 1886, when the work of Hellriegel and Willfarth and others demonstrated the extremely important part played by micro-organisms in the metabolism of leguminous plants, lines of investigation have been opened up that have shed much light on the formation of carbonaceous compounds. The final result towards which these experiments point is the possibility of green plants being able to assimilate, directly through their roots, food materials that already contain complex carbon-compounds. It is only possible here to indicate the links in the chain of argument.

Winogradsky noticed that a certain lower plant, *Clostridium Pasteurianum*, was able to fix nitrogen in direct proportion to the amount of sugar supplied to it in the nutrient media.³ This

1 Deherain. *Exp. Stat. Records*, Vol. ix, No. 10 U. S. Depart of Agric.

2 *Journ. Roy. Agric. Soc.* III, Vol. x, part II, No. 38, p. 414.

3 Winogradsky, *Arch. Sci. Biol.*, 1895, 3, p. 297.

was also found to be partly true of some common moulds, such as *Aspergillus niger* and *Penicillium Glaucum*.⁴ Mazé found that micro-organisms from a leguminous root-nodule, grown on nutritive material prepared from an infusion of haricot bean, are able to fix nitrogen when 2 per cent. of sugar is added.⁵ Bouilhac has found that *Nostoc*, a green alga, in the presence of soil bacteria, fixes nitrogen in the absence of organic matter it is true, but the yield is increased four-fold when a dilute solution of glucose is supplied, and under these conditions the organism can even grow in the dark, and form chlorophyll.⁶ Up to this point it would seem that the fixation of nitrogen is clearly connected with the presence of a carbohydrate, either specially added or present in the tissues of an associated plant, or else, to remove the cause a step further, with the presence of organisms capable of manufacturing suitable carbohydrates. Acting on the suggestion that the vigorous assimilation of nitrogen by the bacteria of leguminous root-nodules, may be due to the carbohydrates present in the legume itself, Golding has carried out pot-experiments on the effect of supplying glucose to bean, lucerne, and clover plants, and finds that a marked increase in growth is produced thereby.⁷ Further, Laurent has shown that seedling plants, such as maize, can grow, increase in weight, and form starch in the sterile solutions and in the absence of carbonic anhydride when glucose is supplied to their roots.⁸ Finally, Mazé, again, working with sterile water cultures, shows that vetches can be grown in the dark, at the expense only of glucose supplied to their roots.⁹ It is true that the green plants employed in these experiments belong to botanical orders that most clearly exhibit the phenomenon of nitrogen fixation through the agency of associated bacteria. Whether plants not distinguished by this property can be made to assimilate carbohydrates directly is the subject of further experiments at the present time. Should this prove possible, then a practical issue, quite apart from the extreme theoretical value of the result, may be foreseen. Sugar and other carbohydrates, though prohibited by their cost for manurial purposes on an agricultural scale, might be valuable agents for a special purpose, such as, for instance, the production of fruit, flowers, and vegetables under glass and with a minimum of sunlight, at periods when they are usually obtained only with extreme difficulty.

There is also evidence in another direction that the chlorophyll theory does not explain all the facts of carbon assimilation and plant-energy. Thus, Green has published experiments from which he draws the conclusion that there exists in plants a power of absorbing and utilising the radiant energy of light, sometimes to a considerable extent, without the presence of a chlorophyll apparatus.¹⁰—*Imperial Institute Journal*.

4 Puriewitsch. *Ber. deut. bot. Ges.* 13, p. 339.

5 Mazé. *Ann. Inst. Past.* Jan. 1897, p. 44.

6 Bouilhac. *Ann. Agron.* 1898, 24 p. 561.

7 Golding. *Journ. Soc. Chem. Ind.*, Vol. XVIII, p. 565.

8 Laurent. *Compt. Rend.* 1898 127 p. 786.

9 Mazé. *Compt. Rend.* 1899, 128, p. 185.

10 Green, *Proc. Roy. Soc.* 1897, 61, p. 25.

Recent sales of some unusual Indian and Colonial Drugs.

At the drug auctions held in London last month, several unusual consignments were offered for sale. Most of these were samples of Indian and colonial drugs which had found their way to the London market, and there was also a supply of *ipecacuanha* root from the East Indies. Particulars of the different articles are furnished by *The Chemist and Druggist* for June 24 (p. 1000).

First in importance is the arrival from Singapore of two bales of *ipecacuanha*, which there is little doubt came from Johore. At present we are entirely dependent upon South America for our supplies of this important drug, and for some time past there has been a considerable scarcity in the market, stated to be due to the fact that the natives of Brazil have, to a large extent, abandoned the collection of *ipecacuanha* root in favour of India rubber. However this may be, the last digging season, which ended in March, only yielded 180 bales of the drug, about a fourth of the average crop, and consequently there appeared every probability of increased scarcity before the next harvest in November. The supply of East Indian *ipecacuanha*, therefore, arrived at a very opportune moment, and in the present condition of affairs a constant supply from the same source would be most welcome. Attempts have previously been made to cultivate the plant, *Psychotria ipecacuanha*, in both India and Ceylon without success, but it appears to grow well in the Straits Settlements, where some years ago a plantation was established in Johore. In 1888 two packages of the root were received from Singapore; it was of excellent appearance, though slightly damaged, and yielded 1·4 per cent. of emetine. Last month, after an interval of eleven years, a further consignment of the same drug from the same locality made its appearance. It was a splendid specimen, clean and well annulated, and realised 12s. 10d. per lb. at the public auction. This compares very favourably with the recent prices of the Brazilian drug, and Mr. J. C. Umney finds that it contains 1·6 per cent. of emetine. There is no doubt that further supplies of this quality would find a ready market here, and the extended cultivation of the plant in the Straits Settlements appears to be worthy of attention.

The other drugs referred to above may be briefly noticed.

Under the name of "Gookhru" a bale of roundish five-cornered fruits, armed with formidable prickles, was offered for sale. These were the fruits of *Tribulus terrestris*, a low trailing plant, which is common throughout India, and belongs to the natural order *Zygophylleæ*. It is known as Gokhru or Ghókru, and the whole plant, but more particularly its fruits, which are always procurable in the native drug marts, are used medicinally throughout India. It is said to possess diuretic and tonic properties, but its chemical constituents are not known. According

to the authors of *Pharmacographia Indica* the fruits contain a body having alkaloidal properties, together with fat and a resin, to the last of which the aromatic odour and taste are probably due.

Another Indian drug was offered as "Bavachi," and consisted of the seeds of *Psoralea corylifolia*, a herbaceous weed belonging to the *Leguminosæ*, and common throughout India. The seeds are ovate or reniform in shape, dark brown in colour, and possess an aromatic and bitter taste, due to the essential oil which they contain. The oil is used by the natives both internally and externally as a remedy for leprosy and other skin affections, and has been strongly recommended for the purpose by Dr. Kanny Lall Dey.

Fourteen bags of bark shipped from Sydney were offered as "Sassafras," a name applied to various plants. The bark in question was probably derived from *Beilschmiedia obtusifolia*, a large handsome tree of Queensland and New South Wales, belonging to the *Laurineæ*, and known as "Queensland sassafras." It is extremely fragrant and possesses aromatic and tonic properties. When dry it is said to yield 770 oz. of essential oil per ton, and also contains 7.5 per cent. of tannin similar to, or identical with, cinchona tannin. Another bale was offered as "Labrador Tea," and consisted of the leaves of *Ledum latifolium*, a small shrub belonging to the heaths, and found in swampy places in Canada and the Northern States. The leaves have an agreeable odour and taste, and are used by the Cree Indians, who name the plant "Maskoego," as tea.

Reference may be made, in conclusion, to a recent communication relating to the important drug, *Strophanthus*. Mr E. M. Holmes, Curator of the Pharmaceutical Society's Museum, refers in the *Pharmaceutical Journal* for July 8, to the difficulty of obtaining in commerce the pure seeds of *Strophanthus kombe*, which agree with the description and colour test of the Pharmacopœia. Commercial *strophanthus* frequently consists of a mixture of the seeds of various species, and is liable to considerable variation. It is pointed out that *S. kombe* is a native of East Africa, and has not yet been found in West Africa, any *strophanthus* seed imported from the West Coast is very unlikely to be the genuine article. Mr. Holmes has ascertained that even the best commercial *kombe* seeds consist of at least two, and probably three, species mixed together, and from specimens of the plants these have been identified as *S. emini*, *S. kombe* and *S. courmonti*. The variety which complies with the Pharmacopœia tests has been determined, and it is proposed in future to import these seeds in the pods, instead of loose, so as to obtain a seed of uniform character. All packages of this genuine *strophanthus* will be marked A. L. C. L. "Mandala Brand," London, and it is hoped that by the use of a pure and uniform drug the somewhat uncertain action of the tincture made from the present seeds will be remedied.—*Imp. Inst. Jour.*

The Hill Forests of Western India.

The following description of some of Bombay forests is extracted from a lecture delivered by Mr. H. M. Birdwood, C.S.I., L.L.D., M.A., given at the "Greater Britain Exhibition" on the 4th of July, 1897; and printed in the Journal of the Society of Arts.

The particular area of which I spoke at the beginning of this paper is within easy reach of the City of Bombay. It includes hilly tracts of country on either side of the range of Western Ghâts, in the Dekhan and Konkan respectively, between the latitudes, roughly speaking, of Bombay and Satara. As compared with other forest areas elsewhere in the Presidency, it is by no means remarkable, so far as the production of valuable timber is concerned; but it is of interest as illustrating generally the methods of the Forest Department; and it is of special interest to the inhabitants of Bombay and many other cities in the plains, as it includes the two popular hill stations of Matheran and Mahableshwar, which owe much of their value as health resorts to their pleasant woods and abounding undergrowth of beautiful shrubs and flowering plants and ferns, which everywhere keep the ground cool, and the air sweet and fresh. Both in climate and splendour of wild woodland scenery they furnish an instructive contrast with those hills of the same tract which have suffered from the destruction of forests in the manner I have already described. An account of the forest flora of Matheran and Mahableshwar will apply generally to similarly preserved portions of the Western Ghâts and the adjoining regions; and, in the time that is left us, it will be sufficient perhaps if I deal only with the flora of these two hills. Their vegetation is not indeed identical. Dr. Theodore Cooke, formerly principal of the College of Science at Poona and an accomplished botanist, who always found his "pleasure in the pathless woods" whenever he could escape from college lectures, has estimated that, exclusive of grasses, about 140 flowering plants are found at Matheran which have not been seen at Mahableshwar, and 130 at Mahableshwar which have not been seen at Matheran. Some of the conditions which regulate the distribution of plants are not indeed equally operative at both places. Mahableshwar is about 70 miles nearer the equator than Matheran. The latter is an isolated hill rising from the plain of the Konkan, midway between the Ghâts and the sea; whereas Mahableshwar is further from the sea, and is to all intents, a part of the range of Ghâts. The highest point of Matheran is about 2,500 feet above the sea-level; whereas the Mahableshwar plateau is at a general elevation of 4,500 feet above the sea and rises at one point to 4,700 feet. These differing conditions are not without their effect. Some plants are found at Mahableshwar which will not thrive on the lower mountain top. Some Matheran plants, on the other hand, find

the higher levels of Mahableshwar beyond their range. I will give a few instances. The most casual observer is struck by the wonderful undergrowth of brake-fern at Mahableshwar and of the arrow-root plant—which in October and November blooms on almost every square yard of the jungle—and by the beautiful profusion of the *Osmunda* fern, mixed with clustering roses and willows, along the upper stream of the Yenna river. At Matheran the brake-fern is scarcely known. In a few years it will be extinct, if it is not already so; for being rare it has been the prey of thoughtless fern-hunters and cannot defy their onslaughts. It would be impossible for any number of fern-hunters to destroy it at Mahableshwar, and so it is left alone. Even if unmolested at Matheran, it drags on at best but a feeble existence. The site is too low for it, the lowest limit of its range in the latitude of Bombay being apparently a little more than 2,000 feet above the sea-level. The *Osmunda*, again, is not known at Matheran, nor is the Willow (*Salix tetrasperma*), nor the Arrowroot (*Hitchenia caulina*), though other allied plants of the order *Scitamineæ* are plentiful enough. On the other hand, there are some wellknown Matheran trees, such as the Kumbha (*Careya arborea*), the Malia or Indian ebony (*Diospyros assimilis*), and the Chandāra (*Macaranga Roxburghii*), which do not grow on the Mahableshwar plateau at all. But after full account is taken of all divergences, it is found that many plants are common to the two hills. Such a coincidence is favoured by the practical identity of their geological formation, and by the circumstance that there is no great difference in the range of their mean temperature at different seasons and in their rainfall. Both Mahableshwar and Matheran are huge masses of trap, capped by a thin layer of laterite. Both are within sight of the sea. Both are swept by the same dry winds in the cold weather, and by the same monsoon storms, and both enjoy the full benefit of the monsoon rains. The average mean temperature ranges at Mahableshwar from 63·3° Fahr. to 71·7°, and from 67·8° to 73·5° at Matheran. The average annual rainfall at Mahableshwar amounts to 281·4 inches, and at Matheran to 224·7 inches. Under such concordant influences, it is not surprising that a marked similarity should be apparent in the general outward forms of vegetation on the two hills, due to the frequent presence of the same characteristic plants on both. Everywhere at Mahableshwar, as at Matheran, we find the Myrtle tribe represented by endless woods of the beautiful Jambul tree (*Eugenia Jambulana*) the Melastomas by the Anjan or Ironwood (*Memecylon edule*), the Laurels by the Pisa (*Litsea Stocksii*), and the Madder tribe by the thorny Gela (*Randia dumetorum*, a small tree, generally a shrub, with numerous stiff branches, armed with spines, and large fragrant white flowers, which turn yellow before they fade. There is the same undergrowth of shrubs and herbaceous

ous plants, the natural orders of *Leguminosæ*, *Acanthaceæ*, and *Compositæ*, being specially and numerously represented. There are many showy climbers, trailers, and creepers, and Orchids and *Dendrobiums* common to both hills; while everywhere the little silver fern covers with equal impartiality every sheltered bank and rock. Some years ago, before leaving India, I prepared for the Bombay Natural History Society's Journal, with the aid of several competent botanists, a catalogue of the flora of Matheran and Mahableshwar. I cannot pretend that it is a complete list, for the simple reason that during the four rainy months of the year, when most herbaceous plants are at their best, the hills are practically inaccessible to Europeans; but in addition to the hill flora it includes some of the more conspicuous plants on the higher levels of the road from Poona to Mahableshwar; and the list of forest trees, which are conspicuous at all times, may perhaps be accepted as complete. It may interest you to know that of the 733 names included in the catalogue, about 125 are the names of trees or sub-trees, as distinguished from shrubs, creepers, grasses, ferns, and undergrowth generally. Of the trees probably not more than ten species have been introduced, and about 115 species are probably indigenous. They constitute but a small portion of the indigenous trees found throughout India, the number of which exceeds 2,000 species, but they give some idea of the diversity of forest vegetation in the limited area under consideration, if we bear in mind that the number of species of indigenous trees in Great Britain is only forty.*

The trees which have been distinctly introduced are the Peach, which is cultivated at the hill station of Panchgani, near Mahableshwar; the Stringy Bark (*Eucalyptus obliqua*), which does not take kindly to Mahableshwar, the rainfall there being evidently too heavy for it, but does better at Panchgani,—which at a distance of only ten miles from Mahableshwar, has a much lower rainfall—though not nearly so well as on the Nilgiri Hills; the *Chinchona succirubra*, which again has not been a success, as on the Nilgiri Hills and elsewhere; the Cassowary tree, or Beefwood (*Casuarina equisetifolia*), which has been extensively planted at Panchgani, but much prefers the lower lands nearer the sea, and especially the sandy beaches of the Konkan coast; the Oak (*Quercus robur*), of which, however, there are very few well grown trees; and the Mulberry (*Morus alba*) which was probably brought from China.

Among the more important or more conspicuous trees which may be regarded as indigenous are two species of *Garcinia*—the wild Mangosteen (*Garcinia indica*) and the Gamboje tree *Garcinia ovalifolia*; and two species of *Sterculia*—the *Sterculia urens*, from the wood of which native guitars are made and the

* Lieut.-Col. Bailey on "Forestry in India," *The Scottish Geographical Magazine* for 1897, p. 572.

Goldar (*Sterculia guttata*), conspicuous by its large, peach-shaped fruit, covered with scarlet down; the Silk-cotton tree (*Bombax malabaricum*), which attains a great size, and is a tree of strange beauty when in full bloom, with its large, showy, rose-red flowers; the Kasu (*Elaeocarpus oblongus*) with leaves turning red in autumn, and clusters of flowers with white-fringe petals and reddish-brown sepals; the Frankincense tree (*Boswellia serrata*) which is plentiful on the Ghat road between Poona and Mahab-leshwar; and another balsamiferous tree, the *Canarium strictum*—yielding a gum, burnt as incense by the hill people at their religious services, and much sought after on account of the rarity of the tree, of which I have found only one specimen at Matheran, to my lasting wonder at its presence there, in a thick wood, far from its congeners, and hemmed in by countless aliens; the *Garuga pinnata* (belonging also to the same natural order *Burseraceæ*), the bark of which is used in tanning; the Indian Satin-wood (*Chloroxylon Swietenii*), an excellent wood for cabinet work of the better kind; the Indian Red-wood or Bastard Cedar (*Soymida febrifuga*), the bitter bark of which is used as a substitute for chin-chona bark; two species of the Jujube tree (*Zizyphus*); the Koshimb tree (*Scheuchera trijuqa*) on the young branches of which lac is produced in many parts of India; the well-known Mango tree (*Mangifera indica*) which is found wild on many hills, though sometimes said to have been introduced by the Portuguese monks from Brazil; the “Flame of the Forest” (*Butea frondosa*), which has given its name,—Palas—in the vernacular,—to the memorable plain of Palasi, commonly known as Plassey; the Black-wood tree (*Dalbergia latifolia*), of which is made the elaborately-carved furniture, which at one time was much prized in Bombay, the beautiful Indian laburnum (*Cassia fistula*); the *Acacia Suma*, from the wood of which Catechu is manufactured; and yet another beautiful representative of the order *Leguminosæ*, the Laeli (*Albizia stipulata*), a very conspicuous tree at Matheran, with clean stem and spreading branches, finely pinnate leaves, and large acacia-like flowers, with numerous, white, lilac-tipped stamens; the Ain (*Verminalia tomentosa*), a valuable timber tree; the Myrobolam tree (*Terminalia Chebula*), which is found in great abundance on Mahableshtar, the fruit—the Chebulic Myrobolam of commerce—being largely exported, coming indeed, for the whole of India, third on the list of exports of forest produce, as regards valuation, and second, as regards quantity; the Jambul tree (*Eugenia Jambolana*), already referred to, which may be regarded as the most characteristic tree of both Matheran and Mahableshtar, impressing as it does, most effectually, its grace of form and beauty of colour on all the landscape and shading the ground everywhere with a cool canopy of sweet-scented leaves; another tree, also of the Myrtle order (*Careya arborea*), which has been already referred to; the Ironwood (*Memecylon edule*), which has also been referred to and is also a characteristic tree of both hills, with its dark shining

leaves, like the leaves of the Camellia; the Benteak tree (*Lagerstroemia parviflora*), which yields a wood of excellent grain for the cabinet-maker; the Kánta Kumbal (*Sideroxylon tomentosum*), a tough, hard-grained tree, as its name implies; the *Bassia latifolia* or Mowrah tree, from which Mowrah liquor is made in other parts of India; and yet a third tree of the Sapodilla order, the Bokul (*Mimusops Elengi*), with dark green foliage and honey-scented flowers; the *Diospyros assimilis*, one of the Indian ebonies; the Kaola (*Symplocos Beddomei*), with blossoms scented like the hawthorn and blue berries; the wild Olive (*Olea dioica*); the Wáras (*Heterophragma Roxburghii*) a tall tree of the Bignonia or Trumpet-Flower Order, with grey pinnate leaves and clusters of showy white bell-shaped flowers; the Teak tree (*Tectona grandis*), the most important of all the forest trees; the Shewan (*Gmelina arborea*), the pale yellow, close-grained wood of which is used for planking, furniture, the panels of doors, &c.; the wild Nutmeg (*Myristica attenuata*); and 15 species of the Laurel order, all notable and some of them very beautiful trees, the two most notable being the *Litsaea Stocksii*, already referred to, a shapely laurel rising to a height of 20 feet or more, and generally assuming a pyramidal tapering form, and displaying whorls of pale bluish leaves—a very characteristic tree of both hills—and a species of Cinnamon (*Cinnamomum Tamala*), of which I have found only four specimens, all at Matheran, a striking and handsome tree, though of no great size, with tufts, when first bursting into leaf, of small, pink, transparent leaves, which afterwards lengthen and become pointed at both ends, and have marked ribs or nerves, and are dark and shining above, and when dried turn to a rich brown, and yield a spicy scent when crushed. These, with several species of trees of the Spurgeflower order (*Euphorbiaceae*), which is well represented on both hills, and includes the *Macaranga Roxburghii*, already referred to, and readily recognised by its large ovate and peltate leaves, and the Hasána (*Bridelia retusa*), a good timber tree, and of the genus *Ficus*, which includes the well-known Banyan tree, the sacred Pipal, the Sycamore tree of the Bible, and other Figs, not so well known; the stately and fine foliaged Jack tree (*Artocarpus integrifolia*), with its enormous fruit, allied to the Figs, the Willow (*Salix tetrasperma*), and the Fish tail palm (*Caryota urens*)—the only palm included in my catalogue—make up a fairly full list of the more conspicuous of the forest trees on the two hills.

I wish I could convey to you something more than a dim conception of the beauty and perennial charm of these Indian woods. But that is beyond my power. It will be enough for me, and I shall be quite satisfied, if, by my narrative, imperfect and meagre though it be, I shall have helped you in any degree to appreciate the value of the great work done by those who have preserved and improved the forest tracts of British India to the lasting benefit of the State and the people.

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Forestry in Madagascar.

Aspect and resources of the forests.—Speaking roughly, the area of the forests in this French colony appears to be about 10 or 12 million hectares (hectare = $2\frac{1}{2}$ acres), but the western and southern portions of the island are so little known that this estimate makes no claim to precision. The forest varies in character according to localities and may be classed generally into three types, viz., the coast forests, the inland forests up to 700 or 800 metres of altitude, and the upland forests, from 800 to 1,300 metres. It is interesting to note that latitude makes little difference, the forests in the north being much the same as those in the south, whereas in Europe, and even in the smaller area of France itself, the northern forests differ widely from those in the south.

Coast Forests.—The forests in the vicinity of the sea, at least for the east coast, are all much alike, with this difference that in the north the more valuable species are more plentifully distributed than in the south. These forests are not usually of large area, and are divided either by swamps and lagoons or by cleared lands. They are characterised by a special type of trees, such as the *nan'lorofo* or copal, the *hintsina* or *Hazelia bijuga*, the *Terminalia catapa* almond, two *Ficus*, other trees called *varongy*, *voapaka*, *nato*, *nanto*, *fantsikahitra*, *fotoro*, *filao*, and among timbers specially suited for cabinet work, ebonies, palissandres, rosewood, and a species of mahogany called in the west *mahibo*. Among secondary species are found a rubber tree, the *barabanja* or *hazondrano*, *Vahea* rubber climbers, *Landolphia* or *Hancornia*, edible fruits like the *voantaka* and lime, also palms and pandanus. These coast forests are valuable because they contain species that cannot be grown elsewhere, and also because they form a protection against strong winds from the open sea which might otherwise prove injurious to agriculture.

Inland or median forests.—The forests of moderate elevation are by far the most important in the island, whether on account of their extent or on account of their richness. In some parts, for instance near the Bay of Antongil, they come almost to the coast.

At similar elevations, the forests of the north-west resemble those of the east, still, from about the 16th parallel, those of the west differ appreciably in appearance and composition from those on the east. In the latter, the Filices are the more plentiful, in the former the Leguminosæ preponderate. Hence results a considerable difference in general appearance. In the east, the broad-leaved species are frequently evergreen, while in the west many are deciduous. It is estimated that these median forests contain about 1,200 woody species, of which 800 attain a height of 8 to 30 or 40 metres. Among those of commercial importance as timber or cabinet woods the following families are represented,

Rubiaceæ—*tambaribarisa*, *sohisy* or *sondindranto* *fansikahitra*.

Saxifragæ—*lalona*, *hazomena*.

Leguminosæ—*voamboana* and other rosewoods, *harahara* one of the hardest and finest coloured woods, *volomborona*.

Malvaceæ—*baobab* or *boutono*, *varo*.

Guttiferæ—*ramy*, one of the most remarkable trees of the family, *foraha*, and *vintonina*.

Chlanaceæ—*fotona* and *anjanajana*.

Taccaceæ—*torolo*.

Conifereæ—*hatrata*, the only representative of the family.

Urticaceæ—*fanidy* and three figs.

Euphorbiaceæ—*tapia*, *voapaka*.

Proteaceæ—*vivaona*.

Monimiaceæ—*ambora*, several varieties, some of which resemble sandalwood.

Loganiaceæ—*lambinana* and *valanirana*.

Ebenaceæ—several species of *Diospyros* (black, green, or striped ebony) called *hazomainty*.

Rhizophoraceæ—*hazomamy*.

Liliaceæ—*vanana*, *hazondrano*.

Sapotaceæ—*nato*, *nanto*.

Lauraceæ—*varongy*, 2 or 3 species.

Compositaceæ—*merana*.

Myrtaceæ—*rotra*.

Terebinthaceæ—*mahibo* or apple-mahogany.

Melastomaceæ—*bongo*.

Bignoniaceæ—*hitsikitsika*.

High level forests.—The forests at high altitudes appear to cover about a fourth of the wooded area of the island, or some 3,000,000 hectares. Where they adjoin the median forests the composition is similar, but gradually alters as the elevation

increases. Cabinet woods are only represented by a few palissandres and some other species not yet fully accepted in commerce.

(Note. *Palissandre* is generally translated rosewood, and is so found in dictionaries. Here, however, some distinction is made.)

There is no more mahogany, no ebony, no rosewood. These valuable species hardly surmount 600 metres, their favourite altitude being 300 to 400 metres. Nevertheless, numerous fine specimens are found in these forests when they are near the sea, both east and west, but specially in the north. These elevated forests are difficult of access, the soil being shallow and steep. They never have that appearance of neatness which is found in those of the lower regions, some of which almost call to mind European forests where great climbers are unknown. Here, on the contrary, is found an inextricable tangle of lianas, climbers of all kinds, bushes, climbing bamboos, and other things which vastly impede progress. Consequently these forests are but imperfectly known, for the more important work at lower levels is enough for the present to claim all the energies of the staff. Nevertheless, it is ascertained that they contain many valuable species, for instance, *lalona*, *hazomainty*, several *voambocana*, a *nato*, *harahara*, *hazovola*, *ambora*, *voanana*, *vivoana*, *varongy*, *famelona*, valued for its elasticity, *hazondrano*, almost as good, *mokarano*, *paka*, *fanidy*, *valarinana*.

All this valuable property has been of late years considerably trenched upon, both by the natives and by foreigners who obtained from the Malagasy government concessions over vast areas which they abused to the benefit of their own pockets and utterly regardless of consequences. This state of things is now stopped by regulations and a Forest Service, drawn up and established by General Gallieni.

Organisation of the Forest Service.—Considering the inadequacy of the budget and the present impossibility of surveying and superintending the whole of the forests properly by means of a full staff, the functions of the forest service are limited to advising the Heads of Provinces, with a view to the preservation and proper working of the forest property. It appears that M. Cornet, Inspecteur Adjoint and Chief of the 1896 mission, has departed, and that the Service now consists of M. Girod-Genet, Inspecteur Adjoint, Chef de Service, two resident gardes generaux at Majunga and Antananarivo, a Brigadier and two gardes at Antananarivo. Another garde general and two more gardes are probably by this time appointed. A school for native gardes is also in course of organisation. Circulars have been issued to Heads of Provinces warning them against alienating valuable forest lands, instructing them in the best means of preserving the forests and assuring their regeneration, enjoining them to prevent damage by cattle, and to keep out fires. Natives are not allowed to scatter about

the forests where they like, but are to be limited to fixed settlements or villages. These steps are stated to be already beneficial.

Reboisement.—Protection alone will not suffice to bring the forests into the highest possible state of efficiency, for there are, especially in the central regions, immense areas where wood is a missing necessity, not only for trade but also for agriculture and the general prosperity of the people, who can obtain neither timber nor firewood at present. The re-clothing of Imerina and Betsileo districts has, therefore, been decided on, and for this purpose nurseries have been started at Antananarivo and in the central provinces. The Antananarivo nursery, adjoining the agronomic station of Nahavisana, is more especially for cultural experiments, with a view to the acclimatisation of useful exotics and to the acquisition of a practical working knowledge of the native species. It possesses already 1,211,650 young plants of various trees, among others *Melia azedarach*, which appears to be the most promising species for the rapid creation of a canopy, several varieties of *flaos* (*Casuarina tenuissima* and *equisetifolia*), *Acacia Lebbek* or *bois noir*, *Acacia heterophylla*, which has given good results, *Eucalyptus robusta* and *botryoides*, *Manihot Glazehovii*, sycamore, Norway pine, chestnut, *Quercus suber* (cork oak) and *robur* and *niaouli*. The provincial nurseries, about eight of them, contain about 4,000,000 plants. Outside Antananarivo an area of 537 hectares has been planted up with 400,000 plants.

Regulations.—The exploitation of forest produce has been regulated by a decree of 3rd July 1897, which permits the grant of concessions under proper control, since it is not yet possible to introduce a system of annual fellings such as obtains in civilised countries. The mode of exploitation is laid down, and the royalty payable by contractors is fixed at 10 centimes per hectare annually up to 20,000 hectares, and 15 centimes per hectare per year over that area. This seems little enough. The natives are allowed to collect minor produce such as rubber, wax, gum, saffron, &c., and to take, for a trifling payment, such wood as they may require for household use, within prescribed areas. The villages are held responsible for frauds or abuses, and are, therefore, less well off than the natives of certain parts of India, where there is every privilege and no kind of responsibility.

Prices.—The values of different articles of forest produce may be interesting. They are as follows :—

1. At Antananarivo :—

1st quality timber,	120 to 130 francs the metre cube	(=34½ c. ft.)
2nd do	105 to 110 do	do
Deadwood	90 to 100 do	do
Charcoal, Native	10 to 14 fr. the 100 kilogrammes	(kilo=2½ lbs.)
Do French-make,	28 fr. do do	

2. At small coast ports, like Vohemar, N'Gontsy, &c.

Rosewood logs, per ton, about	25	fr.
Ebony do do	30	fr.
Palissandre do do	14	fr.
Mahogany do do	14	fr.
Planks per sq. metre do	90	centimes.
Scantling per running metre	3	fr. 50 c. to 13 fr. 50 c.
Shingles (bardeaux) per 100	20	fr.
Rubber, per kilogramme	3	fr. 50 c. to 4 fr. 50 c.
Animal wax do	1	fr. 75 c.
Copal do	1	fr. 40 c.
Rafia fibre do	35	c.

3. At the larger ports, such as Diego Suarez, Tamatave, Majunga, the above prices must be increased by about 30 to 40 fr. per ton to cover cost of freight and transhipment, plus agent's profits.

Introduction of Ceara rubber (Manihot Glaziovii) &c.—The coast regions, possessing a hot and moist climate, lend themselves admirably to the culture of tropical species such as cocoa, coffee, tea, cloves, vanilla, cocoanut, pepper, sugarcane, and rubbers. The climate is not the same everywhere. In Imerina and Betsileo the year is divided between two seasons, dry and cold from May to October, hot and rainy from November to April. But on the east coast between Cape Manambato north of Vohemar and Fort Dauphin these seasons mean merely greater or less heat, with more or less rain. The coast is always hot and moist, with luxuriant vegetation and running streams. Most of the plantations are in the less unhealthy districts, to wit, Sambavaha and Antalaha in the north, Vatomandry, Mahanoro, and Mananjary in the centre of the east coast. Ceara rubber was introduced in 1888, near Fort Dauphin, and some of the plants are now 1 metre in girth and 24 ft. high. Some plants have even seeded at 18 months old, and gave good rubber as an experiment, though plants are not usually tapped till they are 5 or 6 years old. Ceara rubber appears to prefer a dry and rocky soil. It does not prosper in rich moist loam, though the soil into which the young plants are potted out is fairly moist and good. In rich damp soil the trees gradually die off, from no apparent sickness, but the roots form large tubers like those of manioc, and appear to cease their functions. It is expected that the Ceara rubber, cotton, cocoanut, &c., will find a quite congenial home on the west coast, since it has a dry season which will enable them to resist the cryptogamic diseases to which they are liable when grown under continual moisture.

Report of General Gallieni, Governor of Madagascar.

(Abridged from the Revue des Eaux et Forêts)

III.—OFFICIAL PAPERS & INTELLIGENCE.

The spread of Loranthus in the Konkan.*Introduction.*

1. I was first induced to study the spread of Loranthus by reading an interesting paper on the subject in the January (1896) number of the "Indian Forester," Volume XXII, by Mr. H. C. Ashworth, which was taken from the August number of the "Victorian Naturalist." Mr. Ashworth had read this paper before the Fields Naturalists Club of Victoria, and Mr. Clifford forwarded it to the "Forester" with his remarks, hoping that a perusal of it would stimulate interest in the subject in India. In a foot-note to the paper the Editor, Mr. Gamble, added: "The subject of the dispersal of the seeds of the many Indian species of Viscum and Loranthus is one of great interest, and we recommend its investigation to our readers. The genus Dicaeum is rare in India, occurring only in Assam and Burmah, so that other birds are concerned in the dispersal." I commenced studying the subject when I came to Thána in 1897, where the Loranthus longiflorus was observed to be very prevalent. I did my best during that year to ascertain what bird assisted in the distribution of its seed, but was never able to obtain a specimen. An enterprising Forest Guard, however, brought me one and assured me that this was the culprit who spread the seed, and he related that the process was that the bird ate the viscid coating of the seed and, in order to disengage his beak from it, rubbed the former on a branch to which the seed became attached. The explanation seemed reasonable and very probable, and it was confirmed subsequently by some of the Thána wild tribesmen whom I consulted, and also corroborated by the investigations of Mr. Keeble, who, in a paper contributed to the Transactions of the Linnæan Society (copied into the "Indian Forester," Volume XXIII, page 64), wrote (regarding the Singhalese species): "When the fruit is ripe the bird eats the succulent portion only, wiping out the seeds with its beak on a branch of the tree, to which they thus become attached by their viscid coating. If swallowed, the seeds are found to be digested and destroyed." During the greater part of 1898 I was absent from the Thána District, but in the latter part of that year my investigations were recommenced, and I was rewarded early in 1899 by personally seeing the bird, previously shown to me by the Forest Guard, feeding on the Loranthus longiflorus. I watched the bird, and the following is the result of my observations. My conclusions, as will be seen, are entirely opposed to those drawn by Mr. Keeble, and support Mr. Ashworth in nearly every particular.

Loranthus longiflorus on what trees found.

2. *Loranthus longiflorus* is a very common parasite on Teak (*Tectona grandis*) and Mango (*Mangifera indica*), especially in the South Thána Forest Division. Outside forests near villages it is most abundant on Mango, and inside forests on Teak. It is never found, as far as my observation goes, growing on Ain (*Terminalia tomentosa*), Dhowra (*Angogeissus latifolia*), Hed (*Adina cordifolia*), Kalamb (*Stephegyne parviflora*), &c.* It is abundant in the drier parts of the district away from the sea. Nearer the coast, where the climate is milder and at altitudes of about 1,500 to 2,000 feet inland, the mistletoe parasite (*Viscum articulatum*) oftener exists.† Another species, *Loranthus scurrula*, also grows in the forests, but chiefly on Bibla (*Pterocarpus marsupium*) with rusty-coloured flowers.

Pollination of flowers.

3. *Loranthus longiflorus* bears white and red tubular blossoms, which commence to appear in December.‡ The species is ornithophilous and while in flower the bird most effective in its pollination is the *Arachnechthra asiatica*, the purple honey-sucker with a long-curved bill and grey-brown plumage. The full plumage of the male is metallic purple in colour with flame-coloured tufts at the base of the wings.**

In February the fruit commences to ripen. It is red-coloured, oblong in shape, and from $\frac{1}{4}$ " to $\frac{1}{2}$ " long.

Distribution of Seeds.

4. The seed is distributed by *Dicaeum erythrorhyncus*, a small bird about the size of a common Tailor bird, with grey-brown plumage and a light flesh-coloured short bill. The female and male are very much alike.‡

Method of distribution and characteristics of distributor.

The *Dicaeum erythrorhyncus* flits about from tree to tree chirping a while and plucking the *Loranthus* berries. He holds the fruit broadside in his beak, quickly jerks it round, bringing the blunt end towards his mouth, presses the pointed end with his bill till the seed is squeezed from the epicarp into his mouth. He swallows the seed whole, leaving the epicarp in his bill, and

* It is found in Sálsette on *Dalbergia latifolia*.

† In the neighbourhood of Thána both *Viscum* and *Loranthus* are prevalent.

‡ I have observed the parasite in flower in Sálsette in April-May and also in Murbád. General flowering, however, takes place in December-January.

** Mr. Finn, of the Calcutta Museum, very kindly identified these specimens for me.

‡ Mr. Finn also identified these specimens for me.

he then twists the latter about till all the viscid coating inside is extracted, when it is dropped. The whole operation does not last more than about 30 seconds. He never seems to use his claws to hold the seed at any time, nor does he appear to use them for any purpose, judging by the way he once behaved when a seed on one occasion stuck to his body. Instead of using his claws to work it off, as he might have done, he endeavoured to reach it with his bill, and this he failed to do until, at last, the seed had to be removed for him. A comparatively short space of time is required for him to pass the seed. In 8 or 12 minutes from the time of eating he voids it whole: in the majority of instances, without any excrement.

On one occasion I watched him for $\frac{1}{4}$ ths of an hour and in that time he ate and voided 9 seeds; on another occasion 2 in seven minutes. Two or three seeds generally are eaten in succession and voided all together, and there is attached to the cluster of seeds a long film-like substance which helps to make the seeds catch on to the branch when dropped and get glued there. Some discomfort seems to be felt in voiding, and evidently it is not a very easy operation judging by the way the bird behaves, for he jumps up and down and shakes himself vigorously till he has shed it. He works himself up and down in such a manner as to bring his posterior close up to the branch on which he is seated, so that on the thinnest branch of a tree the seed can easily become attached. The seed seems more sticky on emerging from the bird than before entering the mouth, and gets glued to whatever object it meets with. The long film attached to it evidently is a provision of nature to diminish the chances of the seed falling to the ground as it otherwise might do.

The bird also eats the fruit of the *Ficus glomerata*, as I observed, but this is indulged in more apparently when *Loranthus* is out of season.

As far as can be judged, it is not the seed that he seems to care for in the case of *Loranthus*, but the viscid coating around it. I dare say if the latter could be extracted without swallowing the seed this would be done, but the difficulty seems to be when the fruit is in his bill for all the viscid coating to be extracted from the seed without any waste. He gulps down the seed therefore and sucks away at the epicarp.

Loranthus fruit is also eaten by the common grey squirrel. I was under a Mango tree on one occasion looking out for the *Dicaeum erythrorhyncus*, when I observed the squirrel on top of the tree eating the fruit.

The seed in this case was not swallowed; for while standing under the tree, the fruits with the epicarp slightly damaged fell in quick succession on the ground, most of the viscid coating having been sucked out. There were no birds nor any other animal on the tree at the time, which was a small young Mango.

It is probable that other birds pluck the *Loranthus longiflorus* fruit and suck the viscid coating of the seed (children in the Thána District are very fond of this), but none could be found that swallowed the seed whole. The *Dicaeum erythrorhynchos* seems to be the only bird, at any rate in this part of the Konkan, that does this, and he is the distributor of the seed by eating the fruit on one tree and voiding the seed on another, and it is by voiding especially that the latter gets attached to the branches. Squirrels do not remove the epicarp from the seed, and although a seed now and then in falling may stick in a tree, still no spread of the parasite on other trees would take place by such agency.

I have never met with such a restless bird as the *Dicaeum erythrorhynchos*. For several hours he is jumping about and feeding. In five hours he ate and voided 50 seeds, not including the edible portion of *Ficus glomerata* fruit, which he also devoured. I need scarcely explain that my observations were over a bird in captivity; and I had him under observation for 3 days: suddenly on the third day he was found to have flown from his cage. How and when he departed I never could ascertain, but, perhaps, it is as well he regained his liberty, for he could not have been taken about conveniently in the district and, moreover, all the information about him I needed had been obtained. But I first detected him as being a voider and distributor of *Loranthus longiflorus* seed while watching him on trees and not while in captivity. He was, as I have previously stated, pointed out to me as being the culprit; but I never satisfied myself that he swallowed the seed and voided it, till on one occasion I brought him down with No. 10 shot. He was alive and quite vigorous and pugnacious. I killed a second and, in preparing him for despatch to the Calcutta Museum, found two seeds just swallowed inside him. Before I put the first bird out of his misery he tried to void a seed and in this state I despatched the specimen to Mr. Finn, of the Calcutta Museum, who wrote: "You have certainly definitely settled now that the bird feeds on *Loranthus*." It is perhaps as well to mention that the people about the district do not believe the bird drinks water. It is thought that there is a sufficient quantity of liquid in the viscid coating of the *Loranthus* seed to quench his thirst. For two days in the cage he did without water, because none was placed in it. On the third day, however, some was placed inside, and he seemed just to indulge in a little now and then. What he enjoyed most was having a bath.

Suggestions for getting rid of Loranthus longiflorus.

6. The only way of ridding the tree of the parasite is to lop off the branch on which it subsists, as explained in that interesting translation of Hartig's Book on Diseases of Trees by Somerville and Marshall Ward, and this is the method adopted

in Thána. The Forest Blocks here are sub-divided into coupes, one of which is cut every year and closed. In these coupes several standards (about 30 or 35 to the acre) are left standing, and it is usually on the Teak standards that the *Dicaeum erythrorhynchos* deposits the *Loranthus longiflorus* seeds. When the controlling officer comes round, he expects to find all the standards in the coupe exploited during the previous year free of parasites. Sometimes there are a few, at other times many* parasites in a coupe, but never too many for a Forest Guard with the aid of a few village friends to remove. In this way the growth of a large number of trees is annually improved. There is a danger, of course, in Forest Guards, through carelessness or by design, lopping off more of a branch than is absolutely necessary; but if the operations are localised to the coupe of the preceding year, strict supervision over them will not be difficult to maintain. In many instances, where apparent abuse of the practice was noticed, it was found that the explanation submitted by the Forest Guard was satisfactory. The *Loranthus* had taken root on the leading topmost shoot growing out from a perpendicular stem, so that decapitation of the stem was the only course possible. Killing the bird so as to effectually arrest the spread of the parasite for ever and a day, is a measure I would not suggest, for, apart from the cruelty of such a step it would be impracticable, as a small army of special Guards with guns would be needed to shoot the birds and destroy their nests, and then they might not destroy the right birds, for there are several very like the *Dicaeum erythrorhynchos* in appearance in the forests which are insectivorous.

Conclusion.

7. My observations, therefore, are, as already stated, entirely opposed to those of Mr. Keeble, whose investigations were undertaken in Ceylon, where probably the genus *Dicaeum* may be a different characterised bird; but I should hardly think it, for so far away as in Victoria the same genus, as shown by Mr. Ashworth, exists, with characteristics almost exactly similar to the Indian species. The only difference in the method of eating the fruit between the Indian and Australian species is that the former does not open the so-called lid, as shown in the diagram accompanying Mr. Ashworth's paper, but squeezes the seed out of the epicarp with his bill by pressure at the opposite end.

G. M. RYAN,

Deputy Conservator of Forests,

South Thána.

13th June 1899.

**Loranthus* is very abundant in the western portion of the Murbád Taluka.

Notes on the Tubers of the Climbers *Dioscorea bulbifera*.

Introduction.

No mention being made in the Gazetteer of the Bombay Presidency, Volume XXV (Botany), of the important climber *Dioscorea bulbifera* (called Kurva, Karand or Kand in Thána), and from the remark in paragraph 56 of the Northern Circle Annual Report for 1896-97 of the Bombay Presidency, including Sind, the economic value of its tubers as an article of food not being apparently generally known, a short note on this useful plant may not prove uninteresting. Mention of the climber is made in Volume III of Dr. Watt's Dictionary of Economic Products (page 128), but the details I now give regarding its tubers and their preparation for food do not appear in this volume.

Where the tubers are found.

2. The climber possesses tubers which are found about 6" to 1' in the ground at the foot of Ain (*Terminalia tomentosa*), Dhowra (*Agnogeissus latifolia*) and Teak (*Tectona grandis*) saplings chiefly; but it is also to be seen in the open away from tree growth in rocky places, where it is a crawler over rough rocky ground. The tubers are formed in the monsoon months (July-August), and after about 8 or 9 months shrink up, leaving only the outer rind in the soil. Before dying in this manner new tubers are thrown out.

Size of tubers.

3. The size of the tubers varies with the character of the soil. If soft they are large, each having a diameter of 3" or 4". If the soil be hard and gritty, they are small and grow in clusters like small potatoes.

By whom eaten.

4. The wild tribes, Thákurs especially, in the eastern talukas of the Thána District eat these tubers in ordinary years extensively, and in seasons of scarcity, as in 1896-97, live on scarcely anything else. In ordinary seasons they commence collecting the tubers as soon as their supply of food-grains ceases. In the month of March 1897, during the famine, I saw large numbers of women and children belonging to the wild tribes grubbing up these tubers from the ground, both in the open and closed forests: an operation which, of course, was not objected to, it being of material assistance to the Forest Department, which is anxious to rid the younger trees of such climbers. Apart from their habit of climbing on their hosts, the roots, which are in close proximity to the latter in the ground, as a rule must usurp a lot of the nutrients in the soil intended for the tree.

Method of preparing the tubers for food.

5. The tubers are dug out of the soil and washed in clear water and then boiled : after this they are peeled and cut in thin slices and placed in a basket, which is put during the night in running water. In the morning the basket is removed and the tubers taken out and eaten with salt. They are also eaten with milk, and when taken in this manner are much appreciated.

The above process of preparing the tubers for food is resorted to during the monsoon. The process employed in the hot weather is as follows :—

The tubers are peeled and cut into slices, and the latter are buttered with ashes of *Phaseolus mungo* (*black-gram) husks and then boiled. After this the slices are washed and re-boiled with salt, and eaten. The process of boiling twice is resorted to, to mitigate the bitter taste of the tubers. If the ashes of the husks of black gram are unobtainable, ordinary ashes from a wood fire are used to butter the slices of the tubers

Report of analysis of tubers by Mr. Hooper, F.I.C., F.C.S.

6. I have received* copy of a report on the analysis of a sample of tubers made by Mr. D. Hooper, F.I.C., F.C.S., Curator, Economic and Art Section, Indian Museum, Calcutta, in which he mentions that the dietetic value of these tubers, compared with potatoes, shows that the amounts of the proximate constituents are very similar and the tubers appear to be equally nutritious. The copy of the report is as follows :—

“The fresh tubers submitted to chemical analysis afforded the following constituents :—

Water	...	...	69.48
Fat, resin, &c.	...	...	3.18
Albuminoids	...	...	1.90
Starch and mucilage (carbohydrates)	...	...	21.97
Fibre	...	...	1.93
Mineral matter	...	...	1.54
			100.

“For the sake of comparing the dietetic value of these tubers with that of the potato, the following results of the analysis of this well-known food is reproduced from Dr. Parke's ‘Practical Hygiene’ :—

Water	...	...	74.0
Albuminoids	...	...	1.5
Fat	...	...	.1
Carbohydrates	...	...	23.4
Mineral matter	..	...	1.0
			100.

*Marathi name *Udid*

"It is here shown that the amounts of the proximate constituents are very similar and the tubers appear to be equally nutritious.

"Certain varieties of yams, however, especially the wild kinds growing in Asia and Africa, have been reported to be poisonous. The toxic principle has been shown to be a glucoside, which is readily removed by water or dispelled by heat. The sample under notice contained a small proportion of a bitter principle. The under-ground tubers of cultivated yams are said to be free from any injurious property, but it would be safer in all cases where wild yams are concerned, to soak them in water, boil and roast them before they are eaten."

G. M. RYAN,

Deputy Conservator of Forests,

13th June 1899.

South Thána.

*Through the courtesy of Major Prain, I. M. S., Royal Botanic Gardens, Calcutta.

Botany and the Indian Forest Department.

In the issue of "Nature" of this date I find the second part of Sir G. King's presidential address of section K, Botany, delivered at the Dover Meeting of the British Association. At the end of that address Sir G. King has made a strong attack on the Indian Forest Department, and on the teaching of Botany at Cooper's Hill College. He maintains that the forest officers trained in this country go out to India with an insufficient knowledge of systematic botany, and that they, on arrival in India, are not encouraged to familiarise themselves with the contents of the forests under their charge.

These assertions are in some respects not in accordance with the facts of the case, and in others they show that Sir G. King, in spite of his long Indian experience, has failed to grasp the real issues. I trust you will permit me to substantiate these two points.

To begin with. Sir G. King puts the cart before the horse. If, as he maintains, the *ordinary forest officer educated in England* now arrives in India without sufficient knowledge to enable him to recognise from their botanical characters the most well-marked Indian trees, it is chiefly due to the fact that it is now-a-days impossible to secure a botanical teacher in this country who can impart the necessary knowledge to the students. Sir G. King feels this himself, hence his lamentations, at the end of his address, over the decay of the study of systematic botany in Britain. I feel sure that Sir W. Thiselton Dyer will bear me out when I state that no botanical teacher has been appointed to Cooper's Hill College except with his, and latterly also with Dr. D. H. Scott's advice. They have been good enough to recommend to us the gentlemen whom they considered most suitable for our requirements, but, alas! not one of them, though all were excellent and even famous botanists in other respects, was a systematic botanist in the sense demanded by Sir G. King. Hence I must turn round upon him and say:—"Provide well-equipped systematic botanists, and we shall be only too glad to have one of them." In other words, the main difficulty lies with the botanists of the present age, and not with the Forest Department.

On the other hand we are not free from blame. Until the year 1890, botany was a compulsory subject in our entrance examination, but in that year it was, against my advice, made an optional subject. This, I believe, was due to the influence of the head-masters of our great public schools, who desired to pass their pupils straight into the Service, without being obliged to teach

special subjects, such as botany. I do not desire to discuss the general question here involved, but I do wish to state that the action in the direction just indicated was decidedly injurious to our special requirements. I am happy to say that during the last year botany has once more been placed amongst those subjects, which every candidate for entrance into the forest branch of Cooper's Hill College will have to take up.

As for myself, I may state that, ever since I started the forest branch of this College in 1885, I have constantly urged our botanical teachers to extend the study of systematic botany at the expense of other branches, such as physiology. But what with young men trained on the ordinary lines of our public schools, and with teachers with a decided leaning to branches of botany other than systematic, it has been a hard struggle. The otherwise excellent teachers of botany, whom we have had so far, did their best to take up systematic botany on the lines required by us, but that is a branch not learned in a day, and the first two of our botanists left us, for better appointments than we could offer, when they had fallen in with our requirement.

And yet I think Sir G. King goes too far when he states that the ordinary forest officer educated in England is unable to recognise from the botanical characters the most well-marked Indian trees. Cases like this do, no doubt, occur, but I am sure that Sir G. King's assertion does not hold good in the case of many of the men who have been sent to India. Indeed, several of them have developed a decided leaning towards systematic botany. At the same time, the task is, in a great part of India, far more difficult than would appear from Sir G. King's words. I should like to know what he understands by "the most well-marked Indian trees." There are some 4,000 different species of trees and woody shrubs in Burma and about half that number in Bengal-Assam. If Sir G. King expects our forest officers on arrival in the country to recognise even a moderate fraction of these species, then he aims at impossibilities, and his enthusiasm for systematic botany has carried him far beyond reasonable limits. To do what he requires demands a thoroughly trained botanical specialist, and even such a one would require many years to become acquainted with the trees, shrubs and herbs (as demanded by Sir G. King) of an Indian jungle in Burma, Bengal and many other parts of India. For such things the ordinary Indian forest officer has no time.

The statement made by Sir G. King, that the young forest officer on arrival in India is not encouraged to familiarise himself with the contents of the forest under his charge, is not in accordance with the facts of the case. On the contrary, it is made the first duty of the young officer, apart from the study of the language of the people. Sir G. King himself enumerates fourteen forest officers who, during the last thirty years, have done good botanical work. Of these, five have made important contributions to

the systematic botany of India. Of the other nine, one was trained at Cooper's Hill. Considering that all the men sent out from Cooper's Hill are as yet young, and that to my certain knowledge several of them are likely to become botanists, I think Sir G. King's strictures are not justified. Unfortunately, he looks at the matter entirely from an enthusiastic botanist's point of view.

The Government of India does not wish every Indian forest officer to be a botanist. It is desirable that every now and then one of them should take up the subject as a speciality, but it would be disastrous if all took that line. I have no hesitation in saying that as soon as a forest officer takes up botany as a speciality he is, rare cases excepted, likely to become an indifferent forest officer. The ordinary officer of that class has no time for special botanical study.

Forestry is, perhaps, not a science in itself, but an industry based upon various branches of science, amongst which botany, geology and entomology are the most important. The forest officer cannot be an expert in each of these. To demand such a thing would be just as reasonable as to demand that a medical man should be an expert in chemistry. The one is as impossible as the other; to become either takes practically a life-time. With the enormous growth of the several branches of science, a very minute specialisation has become an absolute necessity, since only a small fraction of men can be called geniuses, while the rest must be rated at the average capacity of the human race. The students of one branch must depend on the work of students in other branches. Thus, the forester, instead of being the assistant of the botanist (as Sir G. King seems inclined to demand), must rely on the professional botanist for all the finer and more intricate problems of botany. All he requires is to acquire a sufficient knowledge of botany, so that he may utilise what the professional botanist tells him. For more he has no time, because he has to attend to quite another class of business. The Indian forest officer is an estate manager on a large scale; he must manage his estates in such a manner that they yield the largest possible amount of useful produce with the least possible outlay. For that end his time is taken up by silvicultural and administrative duties leaving but little of it for the special study of any of the branches of science upon which systematic forest management is based.

No doubt many of the pioneers of Indian forestry were botanists, but by no means all. Take, for instance, the protection of the forests against fire, a matter to which Sir G. King gives prominence. He himself states that Lieutenant (now General) Michael was the first who was successful in this direction in Madras. I may add that as far as Central and Northern India are concerned, Colonel Pearson was the first to introduce successful fire conservancy. And yet, neither of these two gentlemen will, I feel sure, claim to be a great botanist.

Sir D. Brandis, to whom, as Sir G. King points out, we owe, for the most part, the organisation of the Indian Forest Department, no doubt was a botanist; but he brought about that organisation, not as a botanist, but as an able forester and administrator of extraordinary energy.

Botany is a branch of science the study of which is most fascinating; but the faculties which produce a great botanist do not necessarily include those which are required to produce a great administrator, and herein lies the difficulty, in so far as the Indian Forest Department is concerned. I could point out more than one botanist who occupied the post of the head of the Forest Department in a province, and who could not be counted amongst the successful forest administrators of India. In nearly all these cases so much time was given to botany that little— or, at any rate, not enough—time remained for the proper administration of the extensive Government forest estates which supply the people of the country with the necessary forest produce, and over and above yield now an annual net revenue of a million pounds. These results would be most seriously imperilled if our Indian forest officers were to take the line which Sir G. King recommends to them.

Cooper's Hill, October 19th.

(Sd.) W. SCHLICH.

From "Nature" of November 2nd, 1899.

Yield Table for Shisham Seedlings at Changa Manga.

I am sending you a yield table for seedling shisham forest at Changa Manga, which may be useful to some of your readers for comparison with the rate of growth, &c. of shisham in other localities and under other conditions than at Changa Manga.

The table is as accurate as I think can be prepared from the available data, and as the plantation has been once worked over, no further data with regard to the rate of growth of seedling shisham will be available for some time. There are sure to be inaccuracies in it, but it is to be hoped that some other officer will undertake to improve on it, as I shall have no further chance of doing so, having been transferred from the Lahore Division to Rawalpindi.

RAWALPINDI,
12th November, 1899.

B. COVENTRY.

Normal growing stock of *Shisham* (*Dalbergia Sisso*) at *Changa Manga* calculated for an area of one acre.

I.—QUALITY.

Age.	VOLUME OF GROWING STOCK IN CUBIC FEET SOLID.				VOLUME OF NORMAL SERIES OF AGE GRADATIONS.								
	Number of trees per acre.	Diameter of mean tree at 4½ ft. above ground.	Height in feet of mean tree.	M. A. I.									
				Material over 2 inch diameter cft. solid.	Faggots 1 in. to 2 in. cft. solid.	Brushwood under 1 in. diameter cft. solid.	Total of all classes in cft. solid.						
1	...	8	4.6	10	1	2	13	13	10	1	2	13	13
2	...	1.5	9.3	34	3	4	41	20	44	4	6	54	27
3	...	2.2	13.4	75	6	8	89	29	119	10	14	143	47
4	...	2.9	17.4	127	11	14	152	38	246	21	28	295	73
5	1,028	3.5	21.2	193	18	20	236	47	444	39	48	531	106
6	808	4.2	25.0	278	25	29	332	55	722	64	77	863	144
7	658	4.8	28.5	337	32	38	457	65	1,109	96	115	1,320	188
8	540	5.3	32.0	435	42	50	567	73	1,604	138	165	1,907	238
9	436	6.0	35.5	623	52	63	744	82	2,233	190	228	2,651	294
10	350	6.5	38.7	765	63	77	905	90	2,998	253	305	3,556	355
11	284	7.1	42.0	912	74	91	1,077	90	3,910	327	396	4,633	421
12	234	7.7	45.0	1,063	87	107	1,257	105	4,973	414	403	5,790	482
13	180	8.2	48.0	1,231	98	123	1,452	111	6,204	512	526	7,242	557
14	152	8.7	50.4	1,412	111	141	1,664	118	7,616	623	667	8,906	638
15	130	9.3	52.8	1,600	126	160	1,886	126	9,216	749	827	10,792	719
16	120	9.8	55.0	1,795	138	180	2,113	132	11,011	887	1,007	12,905	807
17	105	10.3	57.1	1,996	153	200	2,349	138	13,007	1,040	1,207	15,254	897
18	95	10.8	59.0	2,210	169	222	2,601	144	15,217	1,209	1,429	17,855	992
19	90	11.3	60.5	2,435	182	243	2,860	150	17,652	1,391	1,673	20,716	1,096
20	88	11.7	62.0	2,642	196	265	3,103	155	20,294	1,587	1,938	23,819	1,190

Normal growing stock of Shisham (Dalbergia Sissu) at Changa Manga calculated for an area of one acre, seedling forest.

II.—QUALITY.

Age.	Number of trees	Diameter of mean tree at 4½ ft.	Height of mean tree.	VOLUME OF GROWING STOCK IN CFT. SOLID.						VOLUME OF NORMAL SERIES OF AGE GRADATIONS.				
				Material over 2 in. diameter cft. solid.	Raggots 1 in. to 2 in. diameter cft. solid.	Brushwood under 1 in. diameter cft. solid.	Total of all classes in cft. solid.	M. A. I. in cft. solid.	Over 2 in. diameter cft. solid.	Raggots 1 in. to 2 in. cft. solid.	Brushwood under 1 in. cft. solid.	Total of all classes cft. solid.	M. A. I. cft. solid.	
1	..	1.2	3.8	5	.5	.5	6	9	5	.5	.5	6	6	
2	..	1.3	7.4	24	2	2	28	14	29	3	3	35	19	
3	..	1.4	11	54	4	5	63	21	83	7	8	98	32	
4	..	2.4	14.6	97	7	10	114	28	180	14	18	212	53	
5	1,200	2.9	18	146	11	15	172	34	326	25	33	384	77	
6	990	3.5	22	204	16	22	242	40	530	41	55	626	104	
7	804	4.0	24	272	21	29	322	46	802	62	84	948	121	
8	670	4.5	27	351	27	37	415	52	1,153	89	121	1,363	170	
9	554	4.9	30	438	33	47	518	57	1,591	122	163	1,881	209	
10	460	5.4	33	536	40	57	633	63	2,127	162	228	2,514	251	
11	390	5.9	35	644	47	69	760	69	2,771	209	294	3,274	297	
12	325	6.3	38	753	55	80	888	74	3,524	264	374	4,162	347	
13	280	6.8	41	872	63	93	1,028	79	4,396	329	467	5,190	399	
14	..	7.3	43	989	71	106	1,166	83	5,385	398	573	6,356	454	
15	..	7.8	45	1,124	79	120	1,323	88	6,509	477	693	7,679	512	
16	..	8.3	47	1,267	89	135	1,491	93	7,776	566	828	9,190	573	
17	..	8.7	48	1,410	96	150	1,656	98	9,186	662	978	10,826	637	
18	..	9.1	50	1,558	106	166	1,830	101	10,744	788	1,144	12,656	703	
19	..	9.5	52	1,691	114	180	1,985	104	12,435	882	1,324	14,641	770	
20	..	9.8	53	1,829	125	195	2,149	107	14,264	1,007	1,519	16,990	839	

Normal growing stock of Shisham (Dalbergia sisu) at Changa Manga calculated for an area of one acre.

III.—QUALITY.

Age.	Number of trees per acre.	Diameter of mean tree @ 4½ feet.	Height in feet of mean tree.	VOLUME OF GROWING STOCK IN CUBIC FEET SOLID.						VOLUME OF NORMAL SERIES OF AGE GRADATIONS.					
				Material over 2 in. diameter.	Raggots 1 in. to 2 in. solid.	Brushwood under 1 in. diameter.	Total of all classes.	M. A. I. in cft. solid.	Material over 2 in. diameter.	Raggots 1 in. to 2 in. solid.	Brushwood under 1 in. diameter.	Total of all classes.	M. A. I. in cft. solid.		
1	...	9.	3.2	5	...	...	5	5	...	...	...	...	...	...	5
2	...	1.0	6.4	20	1	...	22	11	...	25	1	...	27	27	13
3	...	1.4	9.3	44	3	4	51	17	...	69	4	5	78	78	26
4	...	1.9	12.0	77	5	8	90	22	...	146	9	13	168	168	42
5	...	2.3	14.8	112	8	12	132	26	...	258	17	25	300	300	60
6	...	2.8	17.4	157	11	16	184	30	...	415	28	41	484	484	80
7	1,000	3.2	20	212	15	23	250	35	...	627	43	64	734	734	105
8	820	3.6	22.5	264	18	28	310	33	...	891	61	89	1,044	1,044	130
9	680	4.1	25	333	22	35	390	43	...	1,224	83	127	1,434	1,434	159
10	570	4.5	27.4	402	27	43	472	47	...	1,626	110	170	1,906	1,906	190
11	485	4.8	29.9	478	32	51	561	51	...	2,104	142	221	2,467	2,467	224
12	420	5.2	32.1	553	37	59	649	54	...	2,637	179	280	3,116	3,116	259
13	370	5.6	34.2	641	43	68	752	58	...	3,298	222	348	3,868	3,868	297
14	320	6.0	36	738	48	78	864	62	...	4,036	270	456	4,832	4,832	345
15	295	6.4	38	823	53	87	963	64	...	4,859	333	513	5,795	5,795	386
16	275	6.7	39.6	907	60	97	1,064	66	...	5,766	403	610	6,859	6,859	428
17	260	7.1	41.3	1,010	65	107	1,182	69	...	6,776	483	717	8,041	8,041	473
18	250	7.4	42.8	1,094	70	116	1,280	71	...	7,870	549	833	9,321	9,321	517
19	240	7.7	44	1,204	76	128	1,408	74	...	9,074	694	961	10,729	10,729	564
20	230	8.1	45.4	1,310	83	139	1,532	76	...	10,384	777	1,100	12,261	12,261	613

Age.	YIELD OF FUEL IN CUBIC FEET STACKED FROM ONE ACRE CLEAR FELLED.				YIELD OF FUEL IN CUBIC FEET STACKED FROM ONE ACRE WITH 15 STANDARDS RESERVED.					
	Fuel from 2 in. to 1 in. diameter in cft. stacked.	Fuel from 2 in. to 1 in. diameter in cft. stacked.	Brushwood under 1 in. diameter in cft. solid.	Total of all classes in cft. solid.	M. A. I. in cft. solid.	Fuel over 2 in. diameter in cft. stacked.	Faggots 1 in. to 2 in. diameter in cft. stacked.	Brushwood under 1 in. diameter in cft. solid.	Total of all classes of fuel in cft. solid.	M. A. I. not including standards, cft. solid.
1	17	5	2	12	12	14	4.7	1.0	10	10
2	56	19	4	41	20	52	17.6	3.0	37	18.5
3	124	40	8	84	28	117	36.9	7.2	79	26
4	210	68	14	144	36	200	62.8	12.4	136	34
5	325	100-2	20	220	44	310	93.7	19	209	42
6	456	142	29	317	52	432	129.6	27	297	49
7	635	186	38	425	60	588	170.8	36	400	57
8	813	233	50	550	69	768	216	47	519	65
9	1,032	295	63	694	76	972	265	59	653	72
10	1,255	355	77	844	84	1,180	319	72	792	79
11	1,418	419	91	1,006	90	1,408	374	85	943	95
12	1,744	489	107	1,197	98	1,632	437	100	1,108	92
13	2,020	554	123	1,386	105	1,885	494	131	1,272	98
14	2,316	627	141	1,557	110	2,156	557	131	1,447	103
15	2,625	706	160	1,770	118	2,430	622	148	1,633	109
16	2,945	781	180	1,985	124	2,720	688	166	1,830	120
17	3,275	861	200	2,112	130	3,026	756	185	2,038	125
18	3,625	948	222	2,451	135	3,343	828	205	2,257	125
19	3,995	1,025	243	2,678	141	3,686	893	224	2,486	130
20	4,333	1,102	265	2,917	145	4,000	960	244	2,684	134

Yield Table of fuel from Shisham (Dalbergia Sissu) seedling forests at Changa Manga, calculation made for one acre.

Age	YIELD OF FUEL IN CUBIC FEET STACKED FROM ONE ACRE CLEAR FILLED.					YIELD OF FUEL IN CUBIC FEET STACKED FROM ONE ACRE WITH 15 STANDARDS RESERVED.				
	Over 2 in. diameter cft. stacked.	From 1/2 in. to 2 in. diameter cft. stacked.	Brushwood under 1 in. diameter cft. solid.	Total in cft. solid.	M. A. I. in cft. solid.	Fuel over 2 in. diameter cft. stacked.	Pagots from 1 in. to 2 in. diameter cft. stacked.	Brushwood under 1 in. diameter cft. solid.	Total in cft. solid.	M. A. I. cft. solid.
1	11.5	4	6	7	7	10	3	5	6	6
2	43	13	2	28	14	40	12	2	27	13
3	94	26	5	61	20	90	25	5	60	20
4	166	45	9	110	27	160	44	9	107	27
5	247	69	14	167	33	240	66	14	162	32
6	351	94	21	236	39	336	91	20	226	37
7	470	126	28	317	45	448	119	27	302	43
8	606	164	37	409	51	576	152	35	389	48
9	757	203	46	512	57	720	188	44	486	54
10	928	243	56	625	62	880	225	53	592	59
11	1,116	293	67	751	68	1,056	266	64	711	64
12	1,305	345	79	881	73	1,236	311	75	832	69
13	1,512	393	92	1,019	78	1,430	356	87	962	74
14	1,721	448	105	1,160	82	1,624	403	99	1,092	78
15	1,965	499	117	1,321	88	1,845	450	112	1,239	82
16	2,221	559	136	1,516	94	2,080	499	127	1,417	87
17	2,469	615	151	1,661	98	2,312	546	141	1,551	91
18	2,736	671	166	1,839	102	2,556	596	155	1,713	95
19	2,979	734	182	1,995	105	2,774	646	169	1,850	98
20	3,225	794	197	2,168	108	3,000	700	183	2,012	100

YIELD TABLE FOR SHISHAM SEEDLINGS.

Yield Table of fuel from Shisham (*Dalbergia Sissu*) seedling forests at Changa Manga, calculation made for one acre.
III. - QUALITY.

Age.	YIELD OF FUEL IN CUBIC FEET STACKED FROM ONE ACRE CLEAR FELLED.				YIELD OF FUEL IN CUBIC FEET STACKED FROM ONE ACRE WITH 15 STANDARDS RESERVED.			
	Fuel over 2 in. diameter cft. stacked.	Faggots. Fuel from 1 in. to 2 in. diameter cft. stacked.	Brushwood under 1 in. diameter in cft. solid.	Total of all classes in cft. solid.	M. A. I. in cft. solid.	Fuel over 2 in. diameter cft. stacked.	Faggots. Fuel from 1 in. to 2 in. diameter. cft. stacked.	Brushwood under 1 in. diameter cft. solid.
1	10	4	5	6	6	8	2 2	5
2	34	10	2	28	14	32	8	2
3	72	19	4	48	16	69	17	4
4	123	30	8	85	21	120	28	7
5	184	46	11	123	24	180	43	11
6	260	63	16	174	29	252	59	15
7	348	81	21	233	33	336	77	20
8	434	103	26	290	36	416	97	25
9	547	128	33	365	40	522	121	32
10	660	157	40	442	44	630	145	38
11	785	182	48	525	48	748	167	45
12	909	210	55	607	56	864	192	52
13	1,053	238	64	704	54	1,001	216	61
14	1,211	274	73	809	57	1,148	244	69
15	1,350	303	82	902	60	1,275	270	77
16	1,487	336	90	994	62	1,408	299	85
17	1,657	366	100	1,106	65	1,564	326	94
18	1,797	398	109	1,199	67	1,692	353	102
19	1,977	432	120	1,319	69	1,862	380	112
20	2,150	468	130	1,434	71	2,020	408	122

Reducing Factors.

100 cubic feet stacked = 57 cubic feet solid for fuel over 2 in. diameter.
do do = 17 do under 2 in. do.
Brushwood estimated @ 10 per cent. of total outturn. Loss in conversion estimated at 7 per cent. of total outturn. 1 cubic foot solid dry shisham = 58 maunds.

B. COVENTRY.

Bleeding of Woody Plants.

Professor H. Molisch has made a variety of observations on the flow of sap from woody plants when wounded.

In the case of Palms, Cocos and Arenga, the bleeding, when the inflorescence is amputated, is not due to root-pressure. No sap escapes from borings at the base of the stem, though it pours out abundantly at higher parts, even at a height of 19-28 metres, when the tree is in full leaf. The spadix continues to bleed for one or two days after being amputated. The origin of the osmotic pressure appears, therefore, to be not in the root, but in the axis of the inflorescence in Cocos, and in the upper part of the stem in Arenga. In three woody plants, natives of Java, *Conocephalus azureus* (Moraceæ), *Laportea crenulata* (Urticaceæ) and *Bambusa* sp. there is an abundant bleeding from the stem, with very considerable pressure, up to two atmospheres, even at the time when the plant is in full leaf. The temperature during (our) winter months is very high day and night, with a constantly cloudy sky and daily rains. From incisions in the stem of climbing plants there is a copious flow of sap, both in the tropics and in European species. This sap flows from the vessels, thus explaining their unusual size in climbing plants. The flow is a purely physical result of the exposure of the vessels on both sides, and shows that capillarity cannot play the part either of a water-retaining or of a water-raising force to any considerable extent. The phenomenon takes place in *Vitis* and *Climatis*, in the height of summer even in very dry weather and intense heat.—(*Journ. Royal Micro. Society.*)

Origin of Storax.

At the 12th International Congress of Medicine at Moscow, Herr J. Moeller, who has been occupied for the last 20 years in studying the origin and development of storax, recently showed that this balsam is not produced in the bark, but is formed in the wood; that it is not a physiological secretion but a pathological product which arises after damage to bark or wood. The first effect of a wound is a development of schizogenous glands which are subsequently converted into lysigenous spaces. These facts were verified both for styrax liquidus from *Liquidambar orientalis*, and for sweet gum from *Liquidambar styraciflua*. The experimental proof was furnished by L. Planchon, who found that balsam did not exist in normal plants, and that it occurred only after wounding the tree. The author supports this by noting the result of making semicircular cuts in a *Liquidambar styraciflua* 6 metres high. Where the branches were not wounded there was no trace of balsam; but where the damage had affected the cambium, rows of balsam glands could be detected with a lens. It seems, therefore, indisputable that storax is a pathological product.—(*Journal of the Royal Microscopical Society.*)

Physiology of roots.

Herr A. Rimpach classifies roots under four heads, viz., (1) Nutrient roots, whose sole function is the conveyance of food material to the rest of the plant. The central bundle, which consists chiefly or exclusively of conducting elements, is surrounded by a comparatively insignificant cortical parenchyme, which may entirely disappear. (2) Firm attachment roots. These do not store up food material, are not contractile, and the conveyance of food-material is so unimportant that their sole or chief function may be regarded as the fixing of the plant to the substratum. They are characterised by the large development of stereome and one characteristic of the epiphytic Bromeliaceæ, Araceæ, Cyclantheæ, and of the terrestrial Bromeliaceæ, Gramineæ, and Palmeæ. (3). Contractile roots (*Zugwurzeln*). These contain few or no stereids, while the thin-walled parenchyme is relatively well developed and permanent. Contractile roots may or may not be also organs of storage. (4). Storage roots. The structure of these roots agrees with that of other organs used for the same purpose; they consist chiefly of a permanent parenchyme filled with food-material, and may be swollen into the form of a tuber.

The roots of herbaceous plants may live only for a single year, or for of several years, or may have an apparently perennial existence. They may be produced only at one or two different periods in the same year. The same species may have more than one kind of root, and these may or may not pass into one another by insensible gradations.—*Journ. Royal Micro. Society and Ber. Deutsch. Bot. Gesell.*)

The manufacture of Leather.

Extract from a lecture by Prof. Henry R. Proctor, printed in the Journal of the Society of Arts.

The vegetable tannins form a large class of bodies varying very considerably in their chemical structure, but having in common the properties of precipitating gelatine from its solution, of forming dark-coloured compounds with ferric salts, and converting skin into leather. The function of tannins in plant life is not very clear. They are widely distributed through almost all classes of flowering plants, and occur at times in almost all parts of the plants, but perhaps most abundantly in fruits and barks. They are also very frequent in galls, caused by the attacks of insects and aphides, though they are sometimes credited with being deterrents of insects. A curious point is that even in the same plant different tannins may exist in different parts; thus the

tannin of the bark, the wood, the acorns, and the galls of the oak is distinctly different, though it is quite possible that all of them are mixtures; since, from their uncrystallisable character, any very accurate separation of the different tannins has so far proved impossible, and it is by no means certain that the number of really distinct tannins is a large one.

Besides the chemical reactions which I have stated to be common to the whole class of tannins, there are certain relations in chemical structure which must be briefly mentioned. All tannins belong to the great class of "aromatic compounds," which also includes most of the coal-tar-colours, and many of the most important products of manufacturing organic chemistry. The peculiarity of this class is that all the bodies belonging to it contain a group of six carbon atoms, usually supposed to be linked together in a ring form, which remains unbroken through all the combinations into which it enters. The simplest of these compounds is ordinary coal-tar benzene, a colourless volatile liquid, the molecules of which consist merely of the six-carbon ring combined with six atoms of hydrogen. Closely allied to this is phenol or pure "carbolic acid," which differs only from benzene in having an-O-H group substituted for one of the hydrogens. Other phenols exist containing two-O-H groups replacing hydrogen (dihydric phenols), and three-O-H groups (trihydric phenols). If we represent the benzene ring, as is usual, by a hexagon, of which the angles correspond to the carbon atoms, it is obvious that so soon as we have more than one substituted hydrogen there will be a possibility of different compounds identical in the number and kind of their atoms, but varying as the substituted groups occupy respectively the 1-2, 1-3, 1-4 positions, and so on. Such bodies actually exist, and are known as "isomeric." Thus there are, as might be predicted, three different dihydric, and three trihydric phenols. From each of these bodies organic acids may be derived by substituting the C O. O H group for yet another of the hydrogens. All the natural tannins contain either the dihydric phenol, catechol, or its corresponding acid, protocatechuic acid; or the trihydric phenol, pyrogallol, or its corresponding acid, gallic acid. No natural tannins seem to be formed from any of the isomeric members of the phenol class, though some, in addition to catechol, contain the trihydric phenol, phloroglucol; but it is stated that bodies having many of the properties of tannins have been artificially formed from other phenols.

The tannins therefore fall naturally into two great classes those derived from protocatechuic acid, and which yield catechol on dry distillation, and which may therefore be called the catechol tannins, and those from gallic acid, which yield pyrogallol on heating, and may similarly be called pyrogallol tannins. It is possible, though not certain, that tannins may exist which contain both these groups at once, and it is certain that there are catechol-

phloroglucol tannins, containing both the dihydric phenol, catechol, and the trihydric phenol, phloroglucol. This difference in constitution corresponds to a marked difference in properties. The catechol tannins generally give green-blacks with ferric salts (though infusions of some of the mimosas give violet-blacks, probably from the presence of colouring matters). Their infusions are precipitated by excess of bromine water, and, employed in tanning, or boiled with acids, or even alone, they give dark-coloured, and generally red and difficultly soluble products, which are deposited on the leather, as in the characteristic case of the hemlock bark of America. Similar red products of oxidation or dehydration are produced by exposure to the sun, so that pale leathers from these tannins, such as East Indian sheep and goats skins, tanned with "turwar" bark (*cassia auriculata*), are rapidly darkened by light, and may even be printed under a photographic negative. The catechol-phloroglucol tannins, such as those of cutch and gambier, behave in this respect very similarly to the ordinary catechol tannins. Pyrogallol tannins, on the other hand, give blue-blacks with ferric salts, and no precipitate with bromine water, and usually a pale precipitate of ellagic acid with acids, and on the surface of leather, constituting what the tanners term "bloom." This deposit is not due to the decomposition of gallotannic acid, the "pure tannin" of the shops, and the most important of the pyrogallol tannins, but to the presence, in larger or smaller proportion, of an allied tannin, ellagitannic acid, of which the constitution is very imperfectly understood. Gallotannic acid itself gives no "bloom," though ellagic acid is easily formed from it by the action of dehydrating agents. Divi-divi, myrobalans, sumach, and galls are good instances of pyrogallol tanning materials, the proportion of ellagitannic acid present being largest in the first and smallest in the last. The only tannin of which the structure is approximately understood is gallotannic acid, which was proved by Schiff to be a digallic acid, or acid anhydride of gallic acid; but even in this case it has been lately shown that Schiff's synthetic digallic acid is not absolutely identical with the natural product.

The precipitate which is formed when gelatine and tannin solutions are mixed is not of constant composition, but varies considerably, according to whether the gelatine or the tannin have been in excess at the moment of combination. Its composition is also altered by washing with hot water, so that it has not the characteristics of a definite chemical compound, but suggests rather the result of a chemical equilibrium, such as has been described in connection with the pickling process, though no explanation on these lines has yet been attempted. It is possible that there may be more than one compound formed between gelatine and the tannins, and that the observed irregularities of composition are due to the presence of the two compounds in varying proportions.

The popular idea that modern tanning is done with 'chemicals' as opposed to vegetable tanning materials is altogether erroneous. The great changes which have taken place in tanning methods since the days of our forefathers have been in the first instance mechanical; much work which was formerly done by hand is now accomplished by steam power. In the second place, advantage has been taken of the vegetable products of other lands, often cheaper and richer in tanning matter than our indigenous oak bark, and, therefore, enabling leather to be more quickly produced by the use of stronger infusions, and still more by their systematic change and renewal. The best leathers of the present are probably not only cheaper, but actually better than those of earlier date, and I do not believe that those who are willing to pay a reasonable price for a good material, were ever better shod than at present; though it must be admitted on the other hand, that at a low enough price worse rubbish can be obtained than our forefathers knew how to make, and that, at the same time, it is so well got up that no one but an expert can judge by its appearance.

In older times, oak bark was practically the only tanning material used in England, and its great virtue was that leathers made with it alone were applicable to a great variety of purposes, and that with an honest tannage it was hardly possible to produce other than a fair wearing quality of leather. Among the host of materials now at the disposal of the tanner, there is scarcely one with the same wide range of applicability, and, therefore, much more skill is required in their proper use and combination, while some of them lend themselves readily to the production of qualities, such as weight and colour, which are profitable to the tanner, while offering no guarantee of wear to the purchaser. One of the most important of modern materials, though now in its turn somewhat eclipsed by later introduction, is valonia, the large acorn of an evergreen oak of Asia Minor and Greece, which contains about three times as much tannin as the strongest oak bark, but of a somewhat different character, giving a harder and heavier leather owing to the presence of a larger proportion of ellagitannic acid, which yields much of the white deposit known as "bloom." Another exotic material, of somewhat the same character, but yielding rather a lighter and more porous leather, is myrobalans, the dried fruit of a large Indian tree, *Terminalia chebula*. Akin to this in the character of its tannin, but yielding still lighter coloured, softer, and lighter-weighting leather is the sumach, the leaf of the *Rhus coriaria* of Sicily, which is used mainly for soft and light leathers such as morocco, in which resistance to water is of small importance. The tannin of sumach is nearly pure gallotannic acid, allied with a colouring matter giving yellow dyes with alum and tin mordants, and which has been shown by Perkin to have interesting chemical relations to the tannin with which it is associated. I must also

mention *divi-divi* and *algarobilla*, the pods of South American trees closely allied to log wood, which are amongst the richest of natural tanning materials, *algarobilla* being perhaps six times as strong as oak barks. The curious name *divi-divi* has a legendary connection with David Davis, who is said to have been the captain of the ship in which it was first imported, but the history of the word *algarobilla* is somewhat more interesting. The Arabic name *al kharrouba* (the locust bean) was introduced into Spain by the Moors and under the Spanish form, *algaroba* is the general name in Spanish-speaking countries for a bean-like pod, of which *algarobilla* is of course the diminutive. All these materials contain tannins mainly of the pyrogallol group, and to them one more may be added which is of constantly increasing importance. The wood of the oak, like most other parts of the tree, contains tannin, yet in very small proportion, say only one-fourth as much as in a good oak bark. It is therefore in itself a practically valueless tannin material, but one to be had in enormous quantities, especially in the great oak forest districts of Slavonia as a waste product from the timber industry. It is, therefore, converted into an extract of at least ten times the tanning strength of the original material. The timber is first reduced to shavings about one-eighth of an inch thick by the action of a machine, of which the essential part is a drum fitted with powerful plane blades on its circumference against which the timber is pressed, the shavings are carried by elevators and chain-conveyers to a series of large vats fitted with steam pipes for heating, and by pumping from one to another of these, tolerably strong liquors are obtained, but of a colour too dark to meet the somewhat exacting requirements of the tanner and his customers, both of whom are ready to sacrifice a good deal of real quality and cheapness to the appearance of boot soles which the first day's wear will irretrievably disfigure! The liquors, therefore, after settling and cooling to a temperature of about blood-heat are treated on precisely the same principle as the cook uses to brighten her jellies, but in the place of white of egg, the cheaper substitute of dried blood or blood albumen is employed. This is dissolved in water and well mixed with the liquor by revolving stirrers, and the temperature is then raised till the albumen coagulates and carries down with it a good deal of the colour and suspended impurities, together with a certain portion of the tannin. The liquor is now settled and the muddy portion filter-pressed; the clear infusion thus obtained is run to vacuum pans and concentrated at a low temperature to an extract of about the consistency of treacle, and containing about 25 to 30 per cent. of tanning matter. Another kindred industry is the manufacture of extracts from the wood of the Spanish chestnut, principally carried on in the south of France where this tree is abundant. The chestnut contains more tannin than oak wood, and the manufacture of the

extract is carried on in a similar manner. The product differs but little from oak wood in its tanning properties, and is so like it in appearance and chemical characteristics that it is frequently substituted by unscrupulous dealers.

So far I have spoken only of tannins belonging more or less definitely to the pyrogallol group. I must now mention some of the derivatives of catechol. Of indigenous European representatives of this class the barks of the larch and the spruce fir are the most important representatives, larch bark being used in Scotland for tanning sheep skins, while spruce bark is one of the most important materials in eastern Germany and Austria. *Curiously, spruce bark is not used in Scotland, and larch bark but little on the Continent, while what becomes of the enormous quantities of spruce bark which must be produced in the Scandinavian forests I have never been able to discover.* Both barks make leather of a pale colour, and, for many purposes, of excellent quality.

Of much greater importance than the European pine barks is that of the American hemlock spruce (*Tsuga* or *Abies Canadensis*) which is one of the principal tanning materials of North America, and which is used not only for the red hemlock sole leather, but either alone or in combination with other tans or with alum for a large proportion of the dressing leather which is exported to Europe. Another tannin of the group in the form of extract under various names which is gradually finding its way into English yards, is from the bark of various trees of the mangrove family, and especially from *Ceriops Candolleana* which is very abundant in the swampy creeks of tropical Africa and the East Indies. Quebracho, the very hard and heavy wood of a tree from the Argentine, belongs to the same class of tannins; and canaigre, the tuberous root of a large dock, is also a catechol tannin, though different in many respects from those already noted. The various mimosas and acacias also belong to the catechol group.

The modern tanning process consists in submitting the hides or skins previously prepared by the methods of liming and bating which have been already described, to infusions of tanning materials, which are gradually increased in concentration as the process advances, and of which the strength is frequently maintained in the later stages by layers of the ground tanning material dusted in between the leather. In earlier days, this dusting was the principal means of bringing the tanning matter in contact with the skins; and much of the increased rapidity of modern processes is due to the use of strong infusions which keep up a better supply of the tannin. The making of such strong liquors without wasteful expenditure of the material is therefore an important branch of the tanner's art. Much of the success of the operation depends on the suitable pulverisation of

the material in the first instance. The tannins are formed in cells with cellulose or woody walls through which, from their uncrystallisable character, they diffuse very slowly, and it is therefore important that cells should be as much broken up as possible in grinding and crushing. On the other hand in dealing with large quantities, it is found that too finely powdered material, when it is wet, presses together into a mass so solid that the liquor will not percolate through it, and it is necessary that it should be sufficiently coarse, or in such a condition that this does not take place. The best way of accomplishing this is dependent on the nature of particular material. With woods it is found that shavings cut transversely to the grain, so as to divide the sap tubes into short lengths, are very satisfactory; barks are best ground in such a way as to rag them as completely as possible without the production of too much fine dust; while many fruits, such as myrobalans and valonia, are better crushed into flakes rather than actually ground. The extraction takes place in large vats or leaches, provided with a latticed or perforated 'false bottom' to allow of drainage; and in the best yards these are generally connected in series of 6-10 vats in such a way that the liquor from the bottom of the weakest and nearly-exhausted vat flows by gravitation on to the top of the next stronger, forcing its liquor down through the false bottom and up a tube on to the top of the next and so on. This method greatly diminishes the labour of pumping and makes it possible to secure a much more constant and systematic change of liquor, which is of great importance, since the dissolved tannin in the material will only diffuse out into liquor weaker than itself, and no length of mere soaking in liquors which are not sufficiently changed will accomplish satisfactory exhaustion. The use of heat is also of great service. Hot liquors not merely extract more rapidly, but bring portions of the tannin into solution which cannot be extracted in the cold. On the other hand, the colour of these "difficultly soluble tannins" is generally darker and redder than that of the more soluble part, so that in many cases it is a question of judgment how much tannin it is worth to sacrifice for the sake of improved colour. It has been shown by the work of Parker, myself, and others, that each tanning material has an *optimum* temperature of extraction at which more tannin can be removed than at any other, but this is sometimes too high for the best results in colour. As a general rule, however, considerably increased quantities of tannin can be extracted by the use of heat, say up to 60°C, on the weaker and nearly-exhausted leaches without any commensurate injury to colour.